CO2 neutralt armatur – CopenHybride

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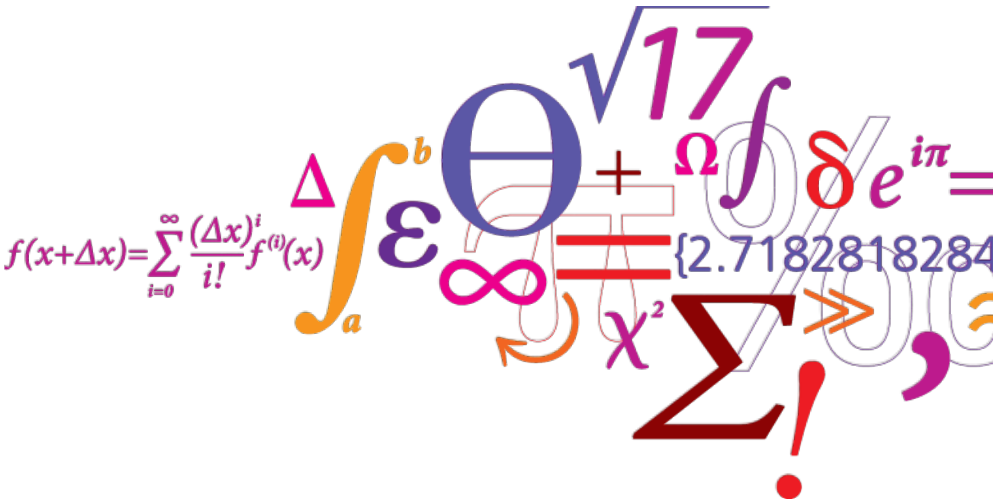
Publication date:
2012

Document Version
Publisher's PDF, also known as Version of record

CO_2 neutralt armatur – CopenHybride

Peter Poulsen – Projektleder - DTU Fotonik RISØ Campus



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HENNINGLARSENARCHITECTS

31. oktober 2012

LED Teamet ved DTU Fotonik – RISØ Campus

31. oktober 2012

Tidligere projekt – LED baseret parklampe

Slutrapport PSO 339-52

Udvikling af miljø- og energirigtig LED parklampe

Albertslund Kommune

Mads Odgård Design

Philips Lighting A/S

DTU Fotonik

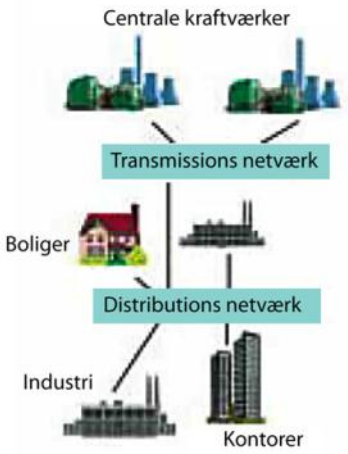
Dong Energy

Arkitektfirmaet ark-unica

31. oktober 2012

Elsystemet

Nutidens elsystem



Fremtidens distribuerede elsystem

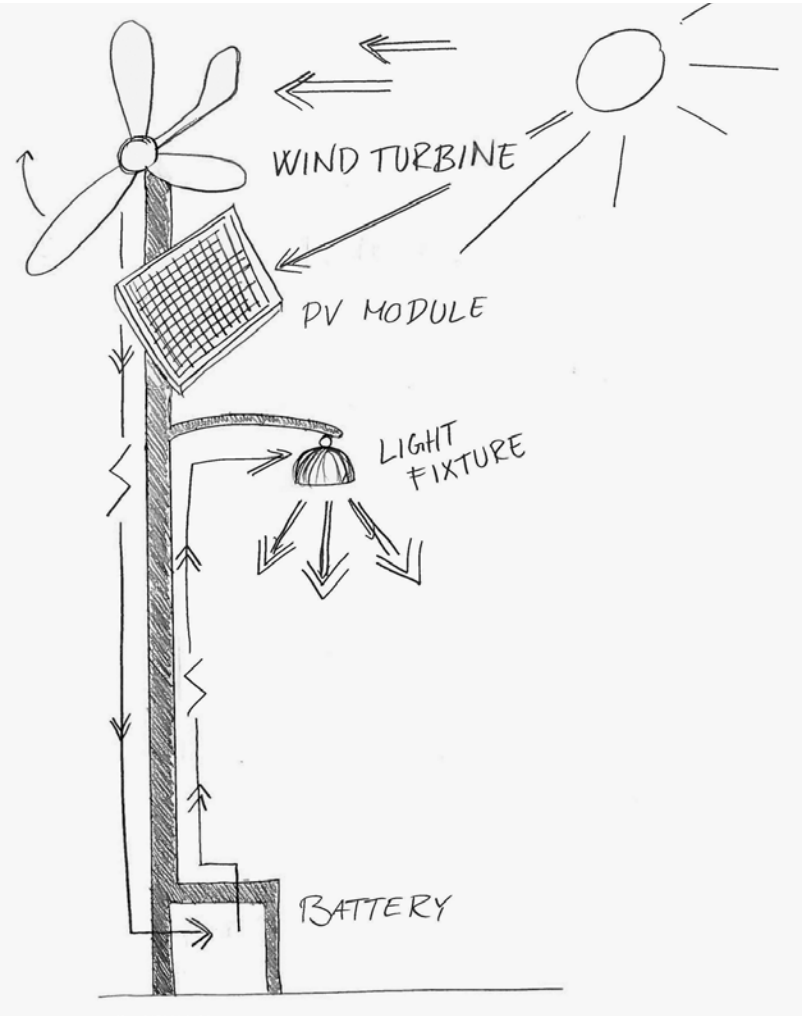
Energiproduktionen rykker tættere på brugerne

31. oktober 2012

Idé / vision

- Stand alone løsning
  - Ingen kabler
  - Opstilling, pæl, LED = gratis
  - Vindturbine, solpanel, batteri
    - Overproduktion
  - Gratis strøm

- CO2 neutral løsning
  - Kabler = gratis?
  - Opstilling, pæl, LED = gratis
  - Vindturbine, solpanel, inverter
    - Ingen overproduktion
  - Gratis strøm



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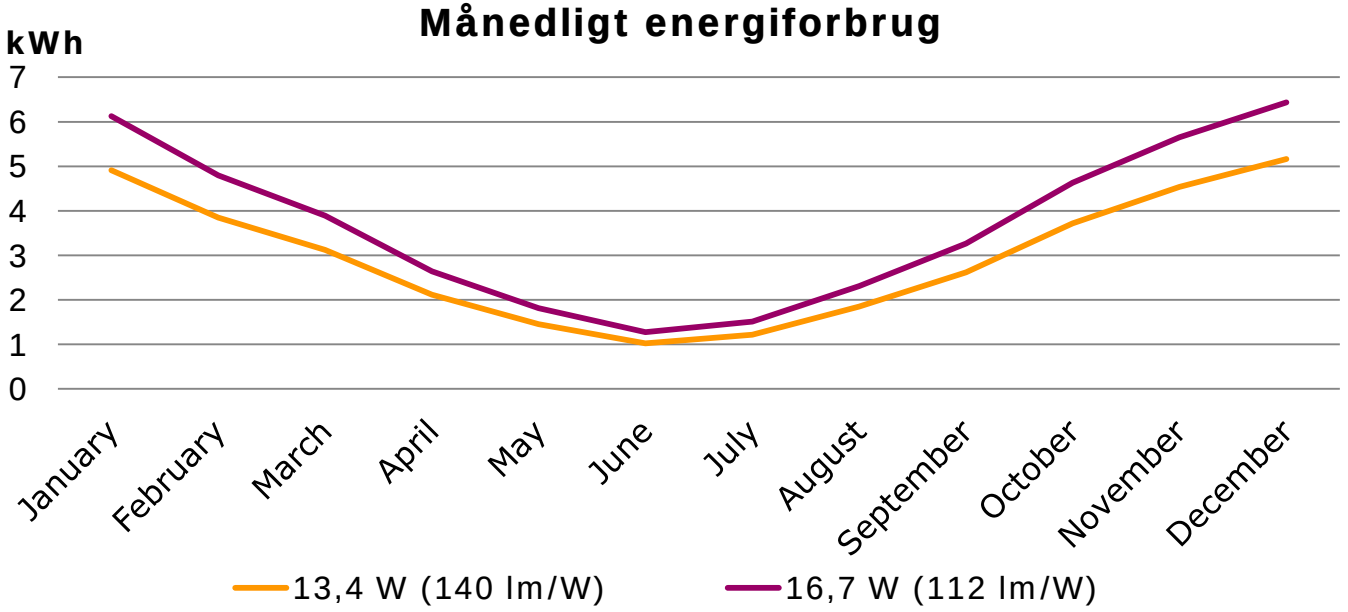
E2 - Lokalvej

- 2,5 lux (hemisferisk illuminans) = 1900 lm
- Farvetemperatur på 3000 K
- Ra-værdi > 80



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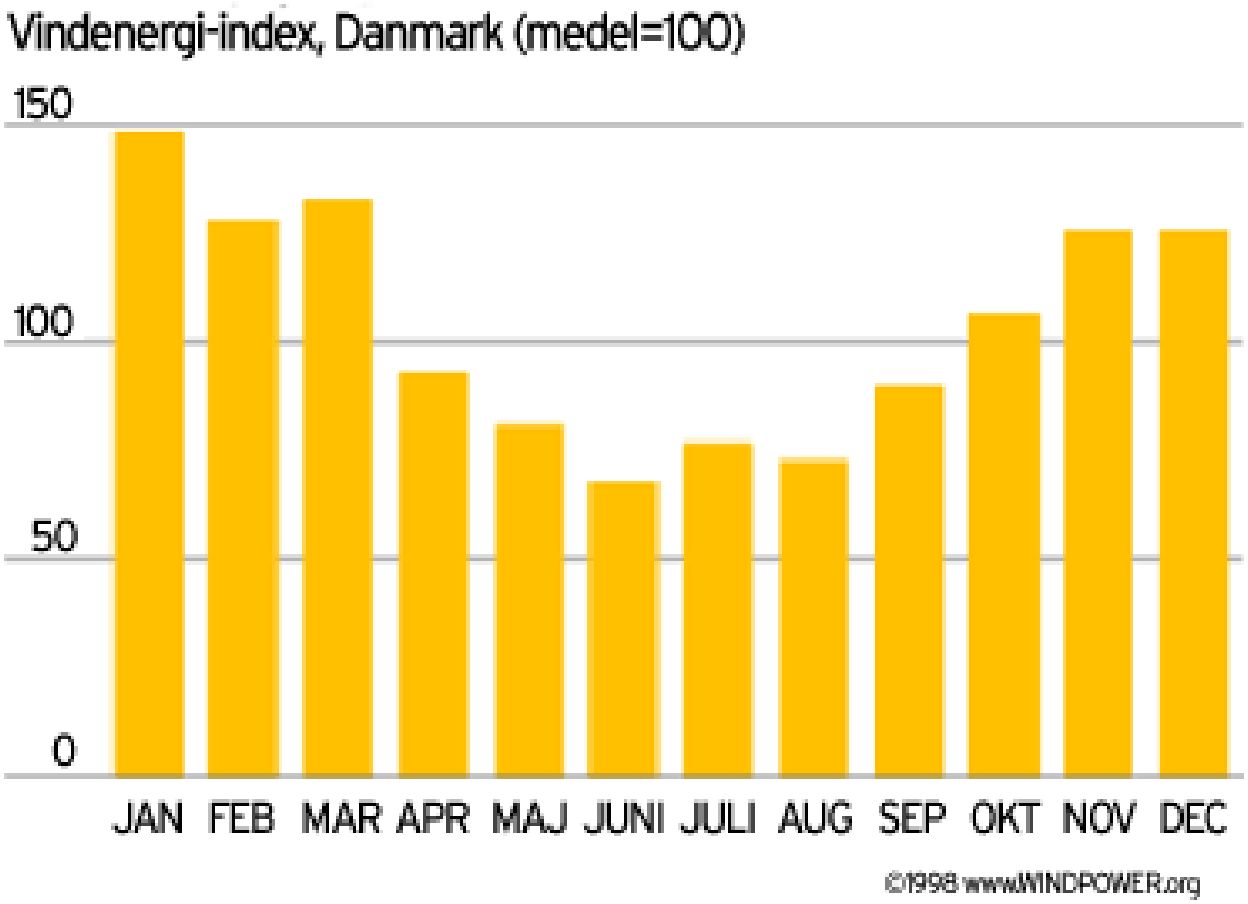
Vindenergi



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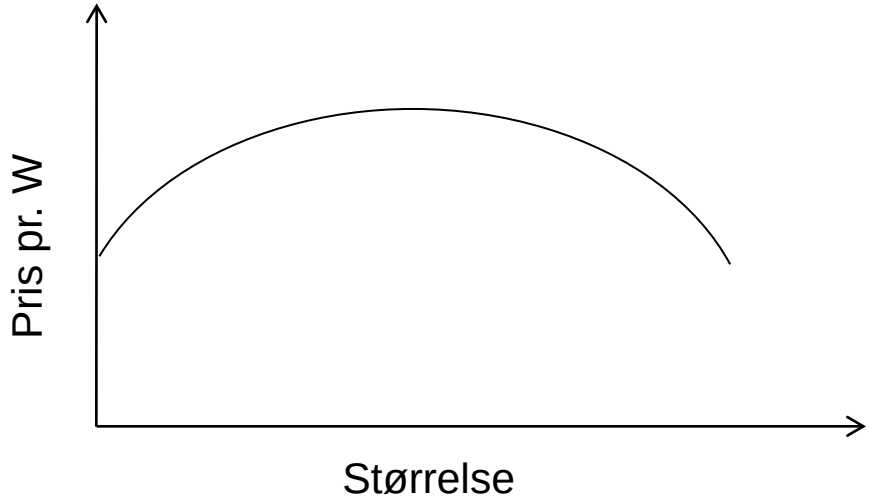
Tiltagende produktmodenhed



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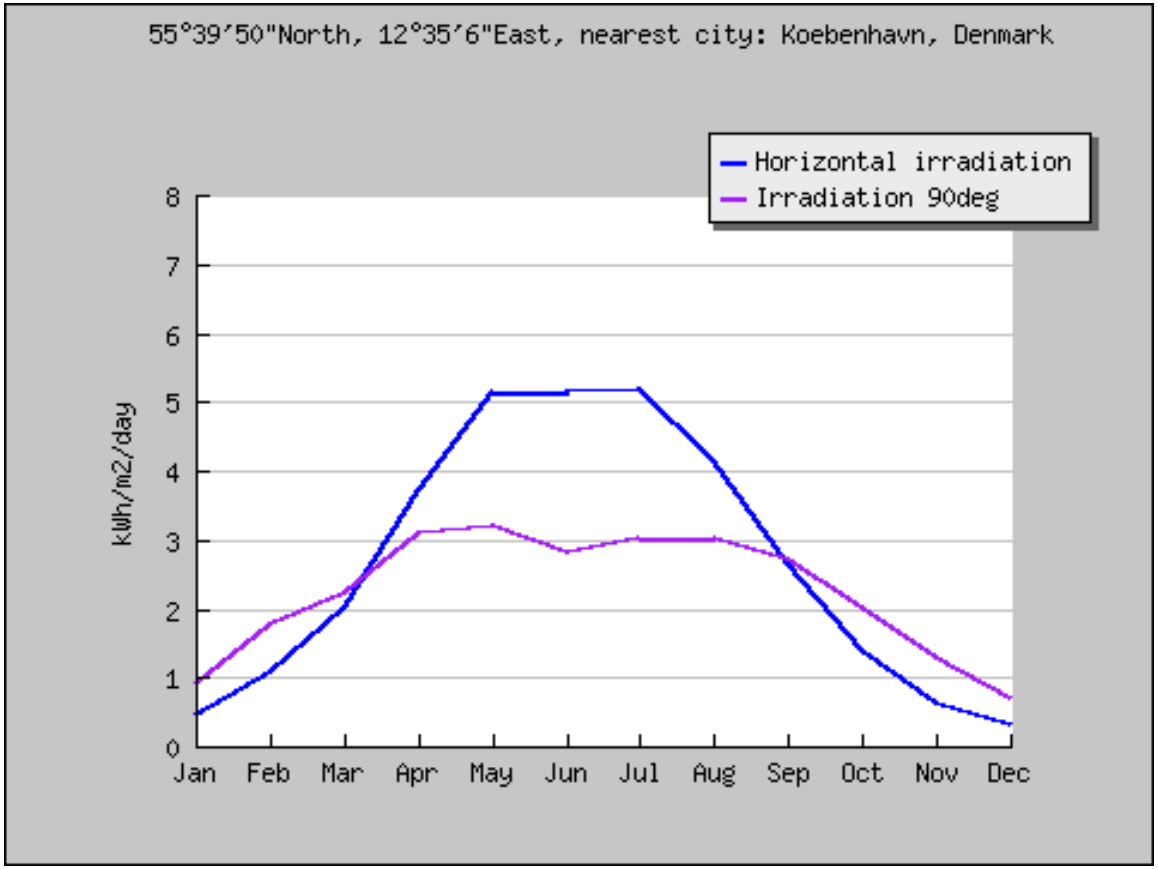
Solenergi



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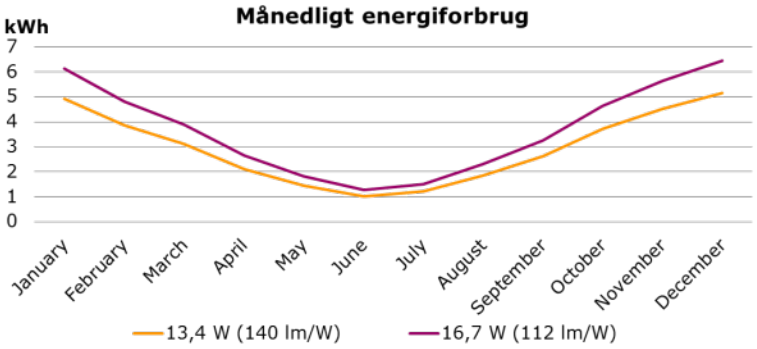
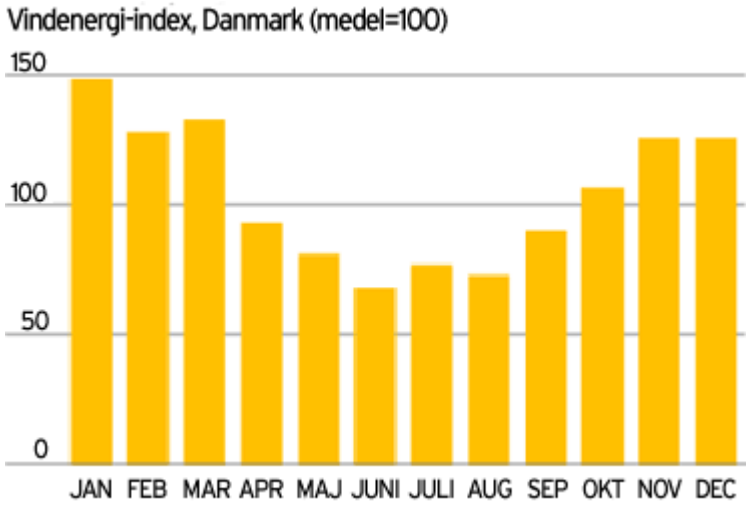
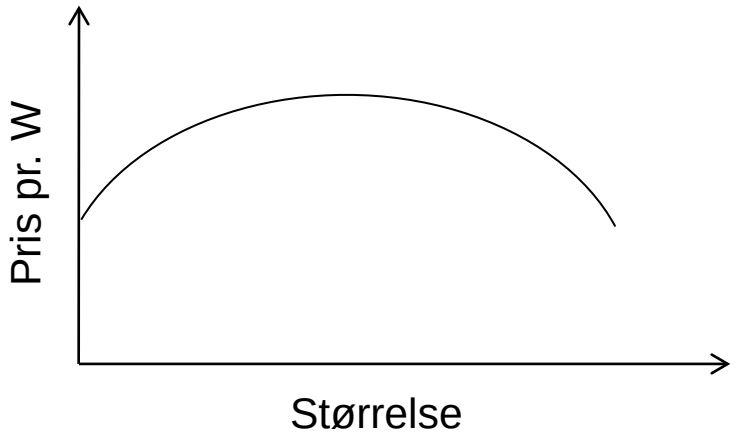
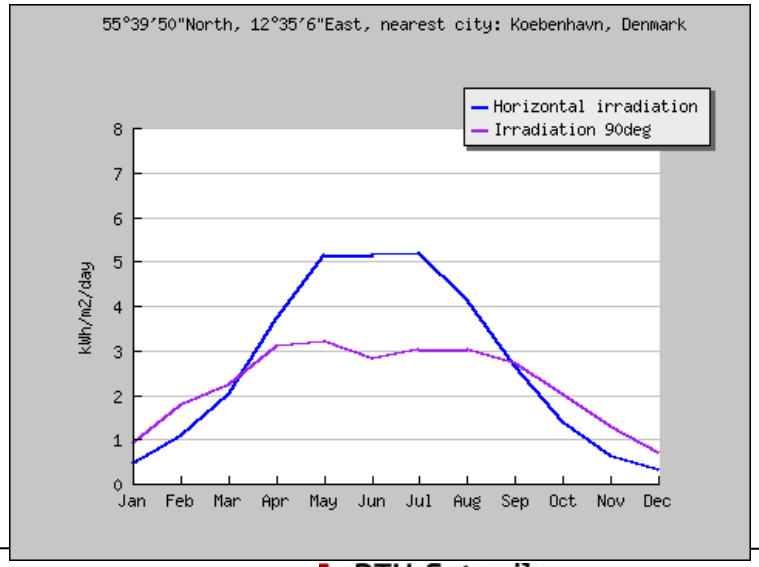








31. oktober 2012

Godt design – vigtigt!!!

31. oktober 2012

Projektteam

Gate 21
Projektansvarlig
Projektledelse

Teknologi	Producent	Brugere/kunder
DTU Fotonik LED-Teknologi	**Philips** LED & Lamper	**KBH Kommune**
DTU Vind Vindteknologi	**Dong Energy** Lamper & Grid	**Albertslund kommune**
Faktor 3 Solcelleteknologi		**Egedal Kommune**
Henning L Design		

31. oktober 2012

Tak til ELFORSK

ELFORSK 343-021 - CO_2 neutralt byrumsarmatur

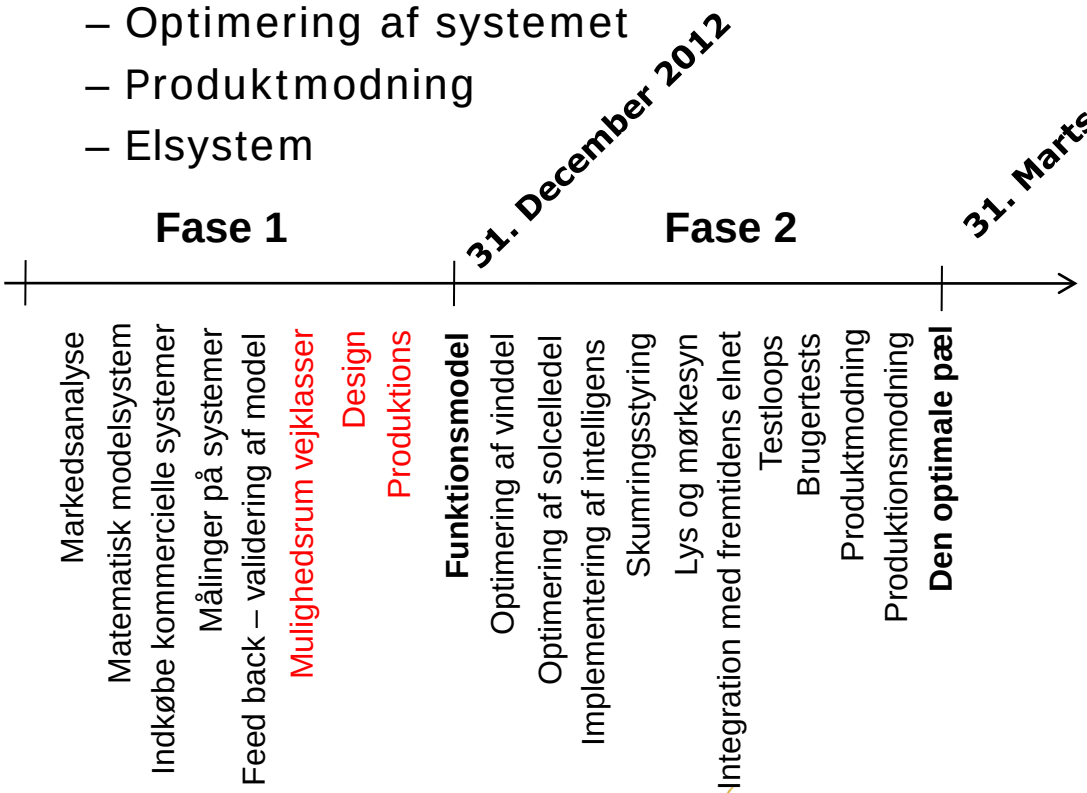
ELFORSK

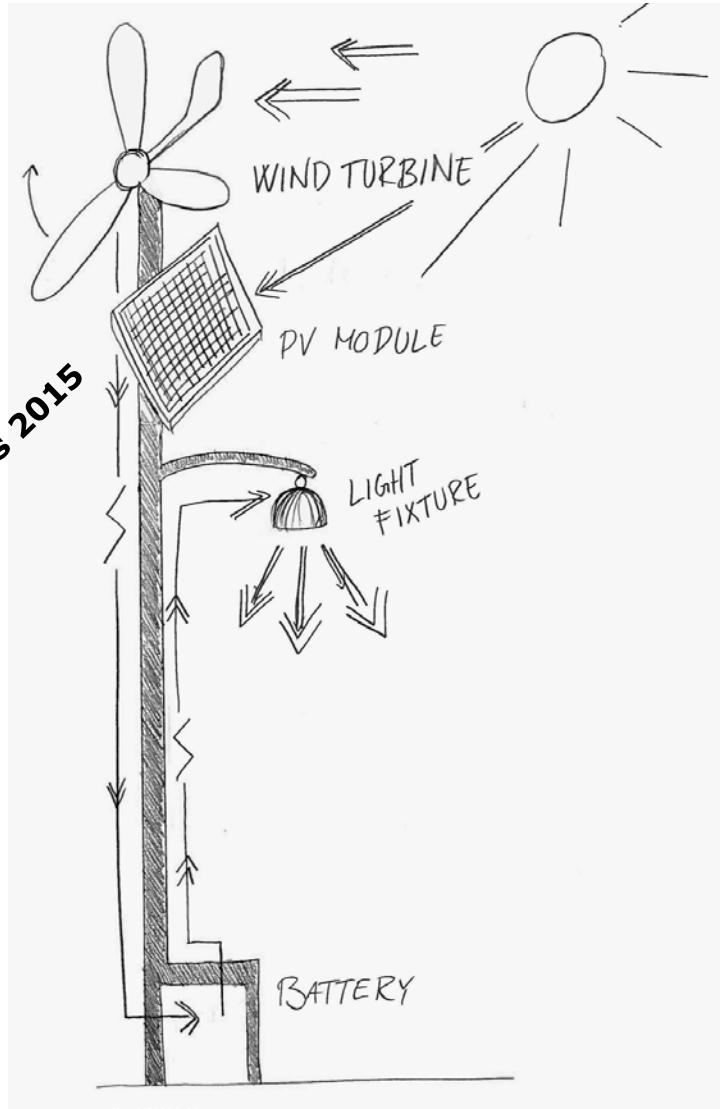
Projektstart 1. april 2011

HENNINGLARSENARCHITECTS

Fase 1 af projekt

- Fase 1
  - Effektiv integration af teknologierne
- Fase 2
  - Optimering af systemet
  - Produktmodning
  - Elsystem





Projektindhold

- Afdækning af kommercielle systemer
- Indkøb af de bedste kommercielle systemer
- Etablering af vejstrækning på RISØ
- Matematisk modelsystem
- Feed back fra kommercielle systemer
- Mapping af energipotentiale som funktion af vejklasse
- Udvælge vejklasse
- Designproces
- Funktionsmodel
- Fremtidsperspektiver – Fase 2

31. oktober 2012

Afdækning af kommercielle systemer

- 29 hybridsystemer identificeret
- Officielt dokument
  - Direktør Center for Trafik
  - Priser
  - Leveringstider
  - Datablade
  - Udsendt 1. februar 2012
- Leverandører
  - Primært kinesiske (nogle med EU salgskontor)
  - 2 USA
  - 2 Canada
  - 2 Korea
  - 1 Frankrig
  - Primært vindturbine leverandører

DTU

Copenhagen January 24th 2012

To suppliers of hybrid street lighting solutions

The capital of Denmark, Copenhagen Municipality is facing a major challenge with its ambition of being CO2 neutral by 2025. Large renovations of street lighting systems will go on in the next few years and this field is therefore on target for special attention, due to the opportunity for realizing large energy saving potentials that new technologies offer, such as LED, solar cells and perhaps small wind turbines when integrated into street lighting.

Denmark has due to its location to the north special challenges due to long and dark winters with very low potential for solar cell energy creation and a high need for lighting due to long dark periods. These periods are though very windy and wind turbine solution seems obvious. The summer period are almost without wind but very sunny due to the very long days and short night time and a solar panel solution is perfect for this period. So to fit the weather conditions in Denmark a CO2 neutral solution for the urban environment seems to be a hybrid solution based on LED, solar panels and wind power technologies.

Since the energy saving need is the same for all the municipalities in Denmark which shall be independent of fossil fuels by 2050, Copenhagen Municipality has teamed up with the Technical University of Denmark to find the perfect hybrid street lighting solutions on the market suitable for fulfilling the lighting requirements in Denmark.

The Technical University of Denmark will in first half of 2012 be obtaining and testing relevant hybrid street lighting solutions under Danish conditions. In order to prepare a recommendation for the Danish municipalities, we are requesting technical specifications, data and prices from suppliers.

We hope that you can help.

Sincerely

Niels Tørslev
Center Manager

CITY OF COPENHAGEN
Technical and Environmental Administration
Centre for Traffic

Risø DTU
National Laboratory for Sustainable Energy

DTU Fotonik
Department of Photonics Engineering

	Windela	Urban Green Energy		Solavero	JL Carbon Free Energy		Remote Hybrid systems	Cygnus		United Electricity	AnHui Hummer Dynamo		Hefei Liuming New Energy Tehnology		Everlast Lighting	Suneco	Nheolis	Linkone Power	MacroWind	Nanjing Supermann Industrial		Jiangsu KingSun Ningbo United Lighting		Shenzhen TIMAR Windenergy etc.		Link Light	Green Power Generator		Windrex	
Response to mail	·	·	·					·	·	·	·			·			·		·	·	·							·	·	·
PV power	·	·	·	·	·	·		·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·
PV technology								·				·	·	·	·		·			·	·	·	·		·					
PV size	·	·															·													
Placement	·																													
PV characteristics		·	·												·		·													
Wind power	·	·	·	·	·	·		·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·
Wind technology	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·		·	·
Rotor size	·	·	·	·	·	·		·	·						·		·			·				·			·			
Rated wind speed	·	·	·		·	·		·	·						·		·			·				·			·			
Power curve available	·	·	·														·			·							·			
Cut in wind speed	·	·	·	·	·	·		·	·						·		·		·	·							·	·	·	·
Cut out wind speed	·																			·				·				·	·	·
Start up wind speed					·	·		·	·						·		·			·				·				·	·	·
Survival wind speed	·	·	·		·	·		·	·								·			·				·						
Blade material		·	·		·	·		·	·						·															
Noise level		·	·	·	·	·																		·						
Light power	·	·	·	·	·	·				·	·	·	·	·	·	·	·	·	·	·	·	·	·	·		·				
Light technology	·	·	·	·	·	·				·	·	·	·	·		·	·	·	·	·	·	·	·	·		·				
Light output		·	·									·	·	·	·		·	·	·				·							
Light efficiency	·											·	·	·																
Light horizontal plane	·																·	·												
Color temperature	·														·		·													
Color rendering index	·														·		·													
Covered area	·			·											·		·	·	·								·			
Battery capacity	·	·	·	·	·	·				·	·	·	·	·	·	·	·	·	·	·	·		·	·	·	·	·	·	·	·
Battery technology	·	·	·		·						·			·	·	·		·		·			·				·			
Number of batteries	·			·									·				·	·	·	·	·						·			
# of days without wind+sun	·	·								·		·	·	·			·	·	·	·	·					·		·	·	·
Lights # of hours	·									·		·	·	·			·	·	·		·					·		·	·	·
Pole height	·	·	·	·	·					·	·	·	·	·	·		·	·	·	·	·	·	·	·	·	·	·	·	·	·
Cost	·	·					·	·	·	·	·			·		·	·	·		·	·			·				·		
Voltage level	·	·	·	·		·					·	·	·	·	·	·	·	·	·	·	·		·	·	·			·		

31. oktober 2012

Udvælgelse af 5 kommercielle systemer

- Leveringstid (kan de overhovedet levere)
- Rotortyper
- Specifikationer
- Kommercielle systemer, der er i marked – også det europæiske.
- Forskellige leverandører

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China Green Power

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United Electricity

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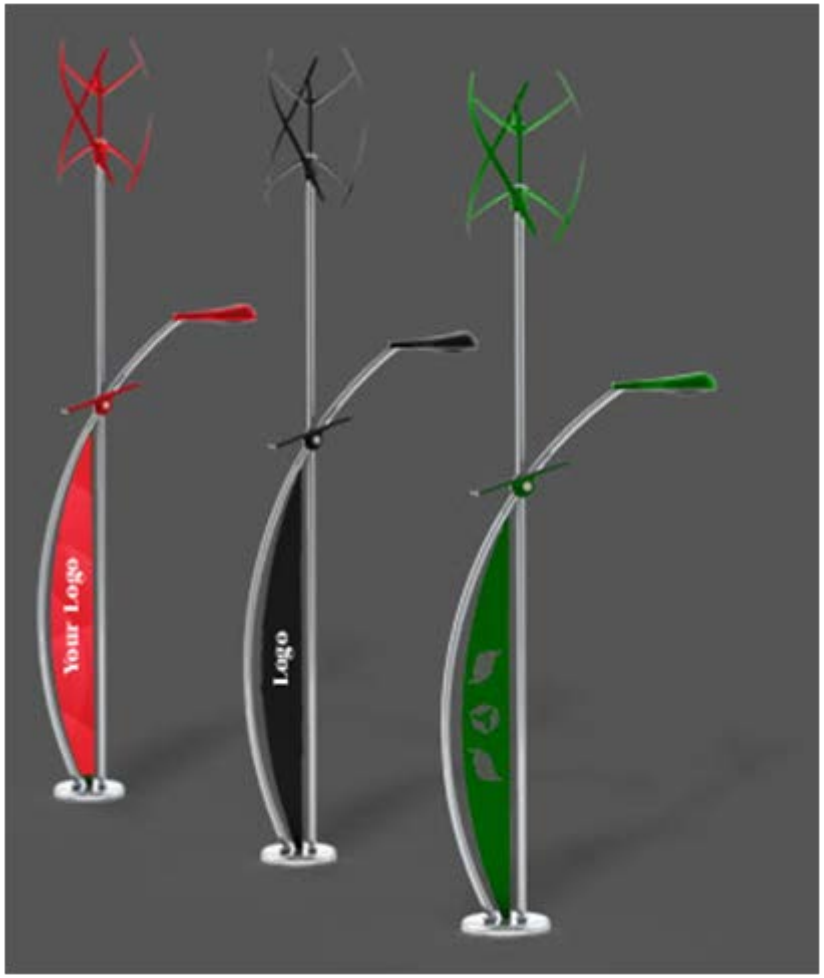
Urban Green Energy



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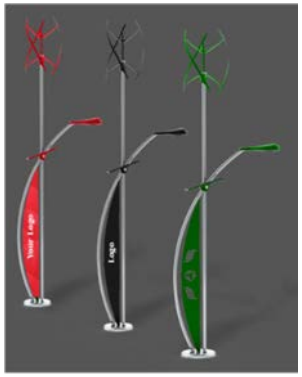
Windela

31. oktober 2012

Nheolis

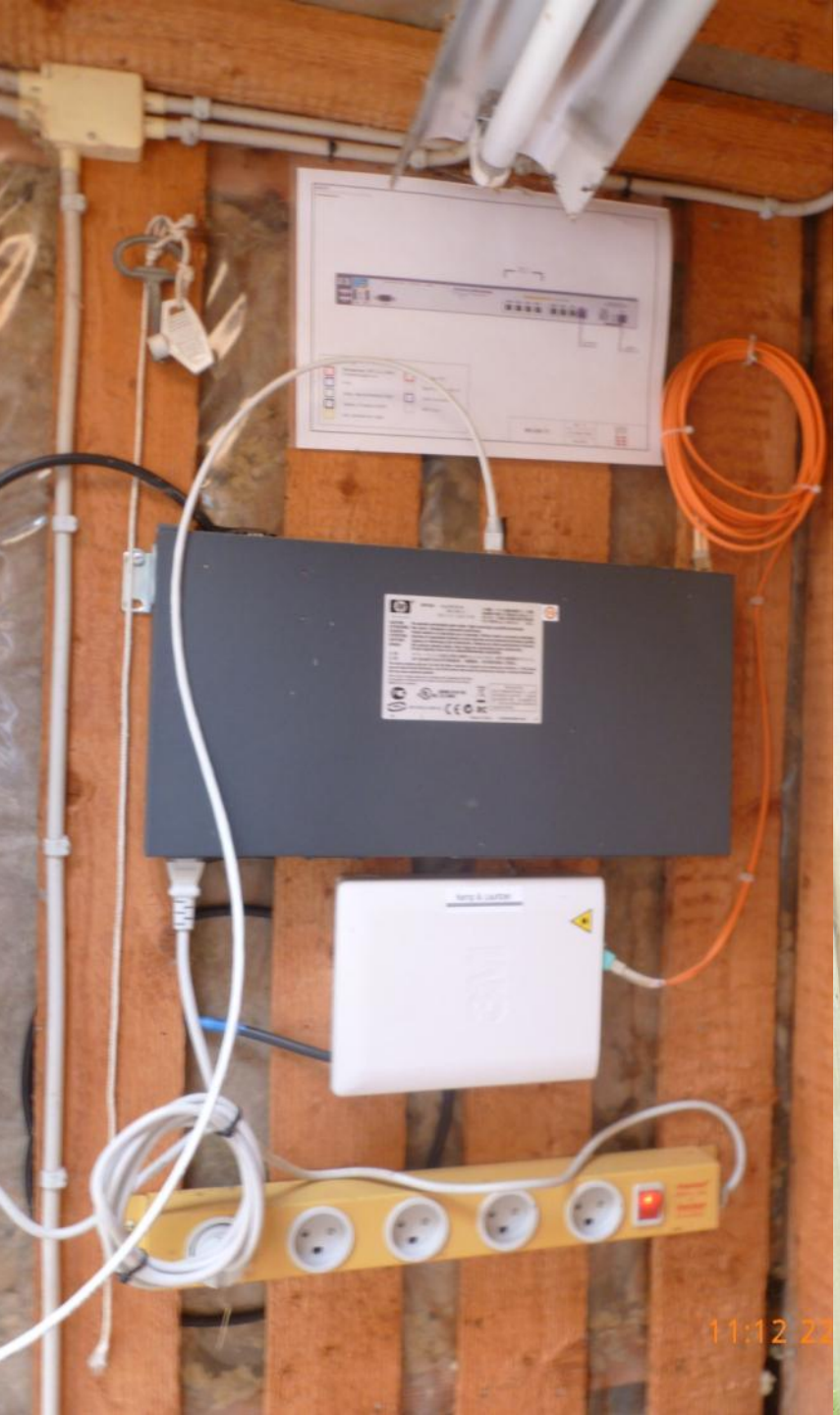
31. oktober 2012

Priser / levering 5 systemer

				
• På RISØ	• På RISØ	• På RISØ	• Afventer stadig	• Kasseret
• 24.000 kr.	• 22.000 kr.	• 9.125 kr. • 5.629 kr. fly • (uden pæl)	• 56.000 kr.	• 35.000 kr. • 27.500 kr mast • 10.000 kr bund


11:15 22/MAY/2012


3
11:11 22/MAY/2012




11:18 22/MAY/2012


nheolis
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11:06 19/JUN/2012

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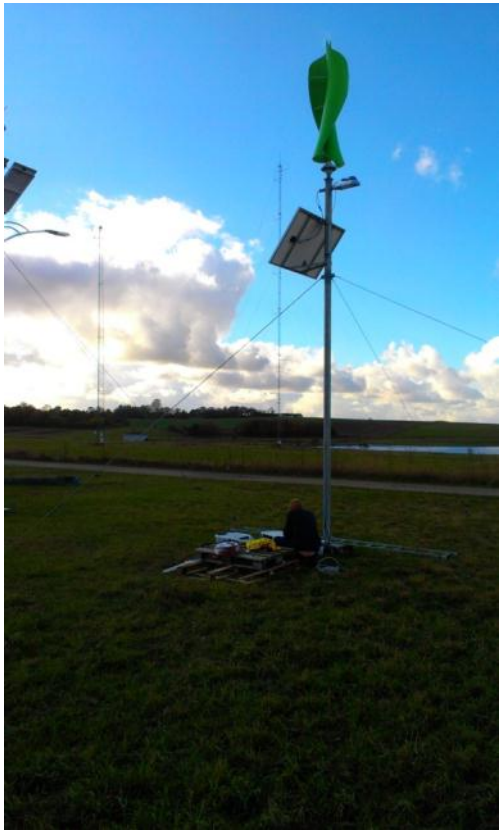
Hybridsystemerne implementeret



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Delkonklusion markedsanalyse

- Umodent marked – primært domineret af kinesiske leverandører
- Virksomheder sælger små vindmøller
- Uoptimerede tekniske løsninger
- Uegnede til danske vejr
- UrbanGreenEnergy virker som en seriøs leverandør

31. oktober 2012

Vind og soldata

- Kastrup lufthavn
- H.C. Ørsteds Instituttet
- House of Dreams
- RISØ
- Forskellige DMI målestationer

- Alle frihøjdemålinger
- Ekstremt dyrt at lave lokale målinger
- Derfor laves i stedet CFD simuleringer

24 Novem ber 2012

31. oktober 2012

Vejklasser - ruhed

Configuration		Characteristics	Roof Shape	z_0	$\overline{H}$	$\sigma_H/\overline{H}$	$\overline{L}/\overline{B}$	$\overline{L}/\overline{H}$	λ_w	λ_{fa}
1		New district, one family buildings 1 - 2 storeys	Mainly gable roofs, rarely flat roofs	0.1 - 0.3 (1.3)	8 - 10	~ 0	~ 1	~ 1.5	0.1 - 0.2	~ 0.1
2		Residential area 1 - 3 storeys	Mainly gable roofs, rarely flat roofs	0.1 - 0.3 (1.4)	8 - 12	< 0.2	~ 1	~ 1.5 - 2.5	0.15 - 0.25	~ 0.1
3		Residential blocks regularly aligned 3 - 5 storeys	Mainly gable roofs, rarely flat roofs	~ 0.3 (1.5)	12 - 20	< 0.2	< 0.5	~ 1 - 2	0.1 - 0.25	0.1 - 0.25
4		Residential area high-rise buildings and residential blocks 4 - 15 storeys	Gable roofs, flat roofs	> 0.5	> 15	0 - 0.5	< 0.5	~ 0.7 - 1.5	0.1 - 0.2	0.15 - 0.3
5		Cultural facilities churches, schools, etc.in residential areas	Gable roofs, flat roofs	0.3 - 1.5 (2.4)	> 8	> 0.5	0.5 - 2.0	~ 2 - 5	0.1 - 0.3	0.05 - 0.15
6		Block of buildings in City Centers 3 - 6 storeys	Mainly gable roofs, rarely flat roofs	~ 0.7 (2.1)	15 - 25	< 0.3	~ 1	~ 0.7 - 0.9	0.3 - 0.7	-
7		City Center areas including parks, ,high-rise buildings and public facilities	Gable roofs, flat roofs	0.3 - 0.7 (>2)	>15	< 0.4	~ 1	~ 1.5 - 2	< 0.5	0.1 - 0.2
8		Commercial and industrial area 2 - 5 storeys	Mainly flat roofs or gable roofs	~ 0.3 (0.6)	5 - 15	< 0.5	< 1	~ 2 - 5	0.3 - 0.4	0.05 - 0.2
9		Industrial plant with tanks	Mainly flat roof	~ 0.5 (1.6)	10 - 25	< 0.5	~ 1	~ 0.5 - 1.5	0.1 - 0.4	0.1 - 0.2
10		Industrial area 1 - 4 storeys	Mainly flat roofs, rarely gable roofs	0.3 - 0.5 (1.6)	5 - 15	0.3 - 0.5	~ 1	~ 2 - 7	0.2 - 0.4	0.05 - 0.2

Vejklasser

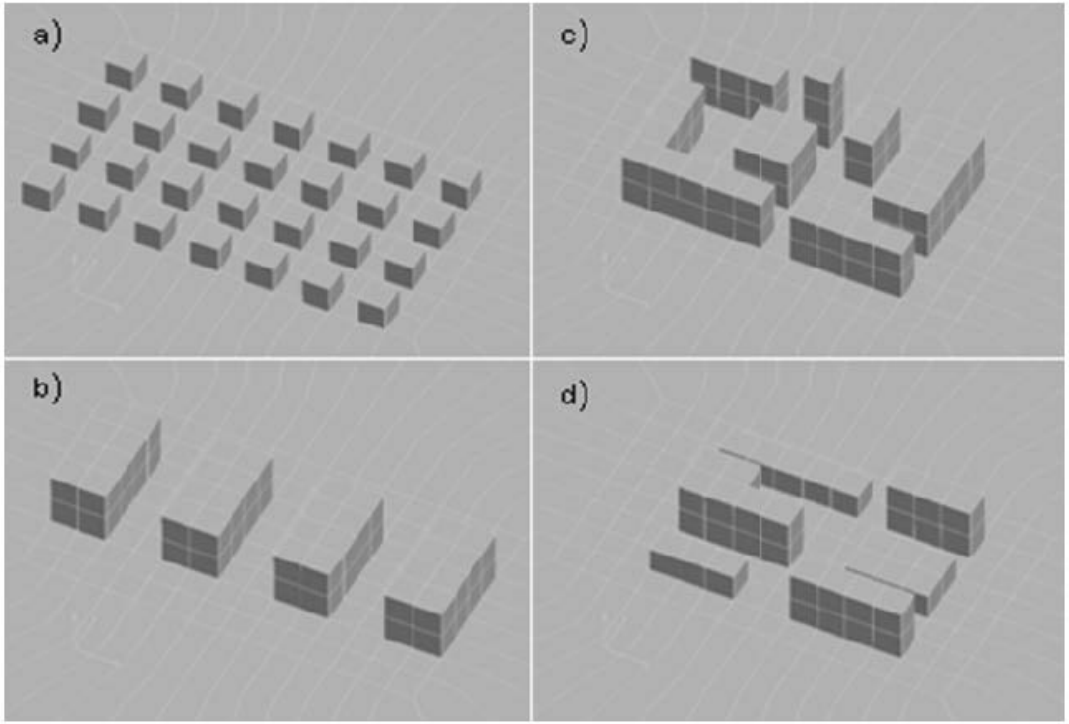

Fig. 30: Picture of chosen building configurations oriented on parameters defined by Badde & Plate. In a) *CASE1*: one family buildings 1-2 stories; z_0=1.3m. In b) *CASE2*: residential blocks regularly aligned 3-5 stories; z_0=1.5m. In c) *CASE3*: city center areas including parks, high rise buildings and public facilities; z_0>2m. In d) *CASE4*: commercial and industrial area 2-5 stories; z_0=0.6m

Vejklasser

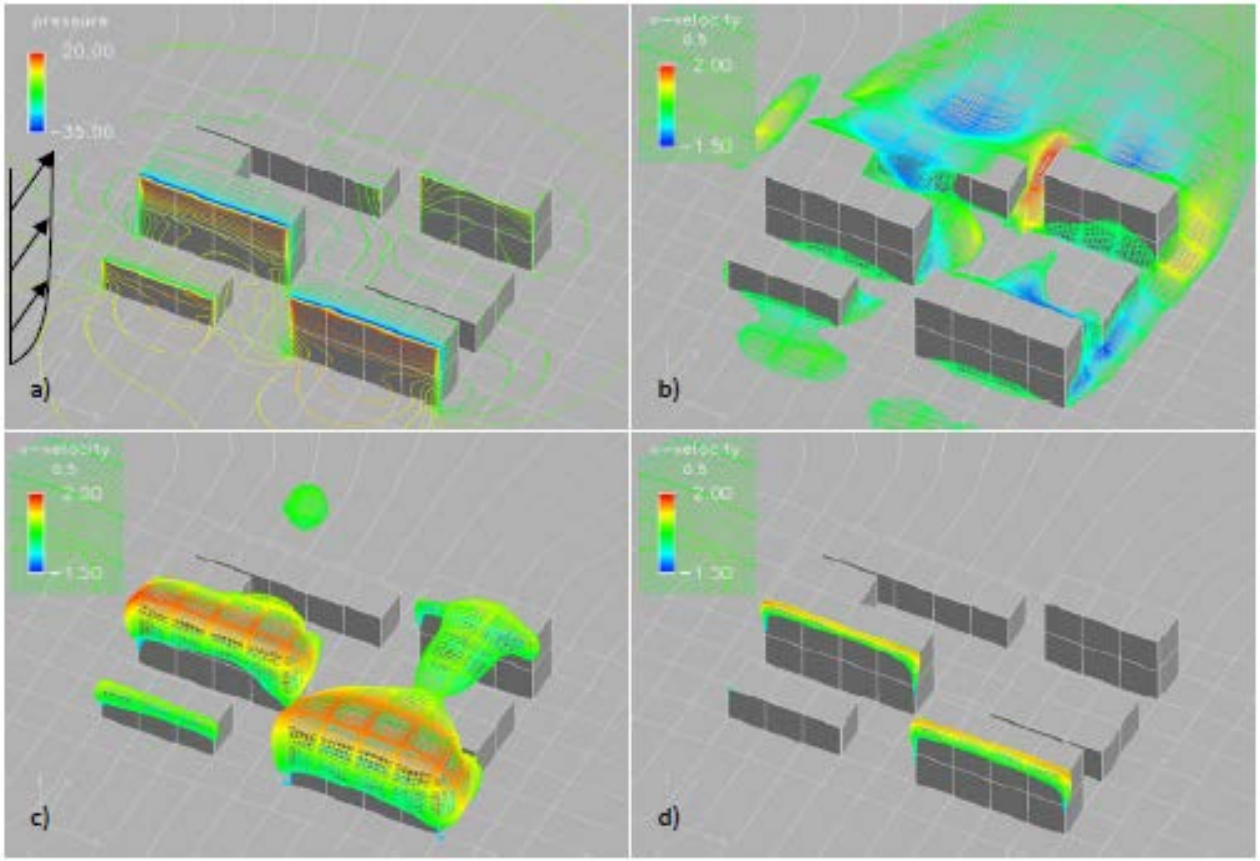

Fig. 33: *CASE4*: a) static pressure distribution; b)-d) *tke* iso-surfaces (*tke*=0.5; 3; 6m^2/s^2) with velocity component *v* distribution

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Højere præcision mulig

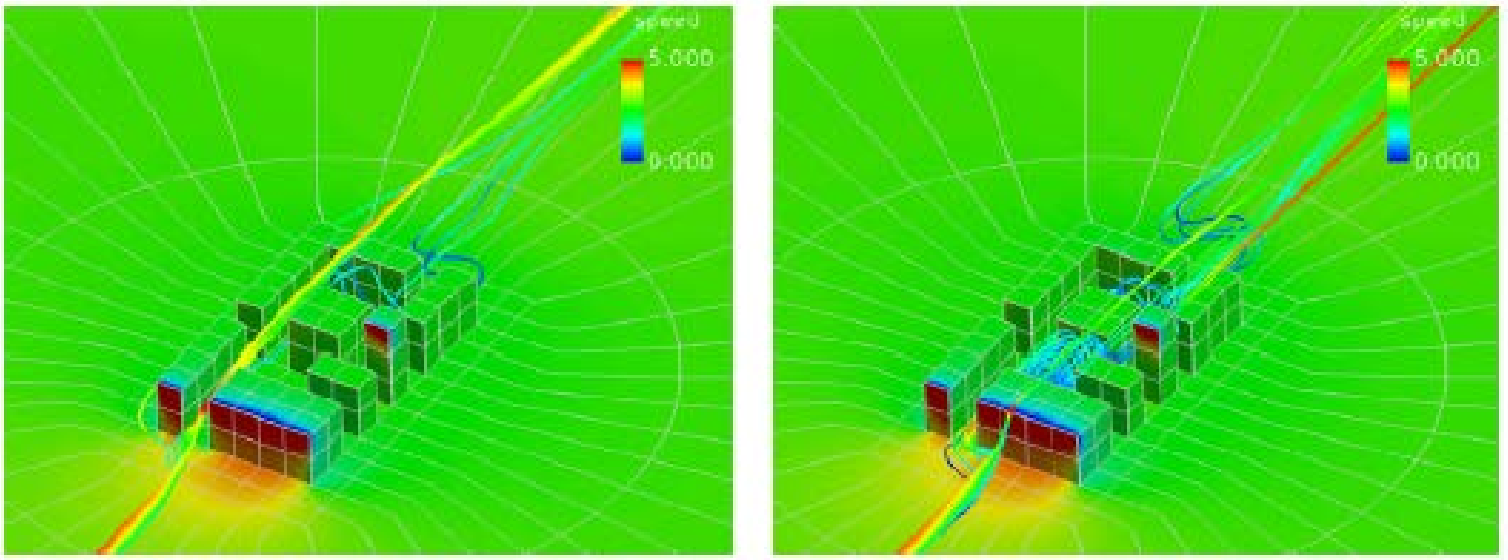

Fig. 35: *CASE3*; left: redirected streamlines accelerated through a street canyon; right: decelerated streamlines at first row obstacle with upwind effect and acceleration at first row roof-edge, partly entering street canyon, caught in ground recirculation zones

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Vindenergifordeling - vejklasser

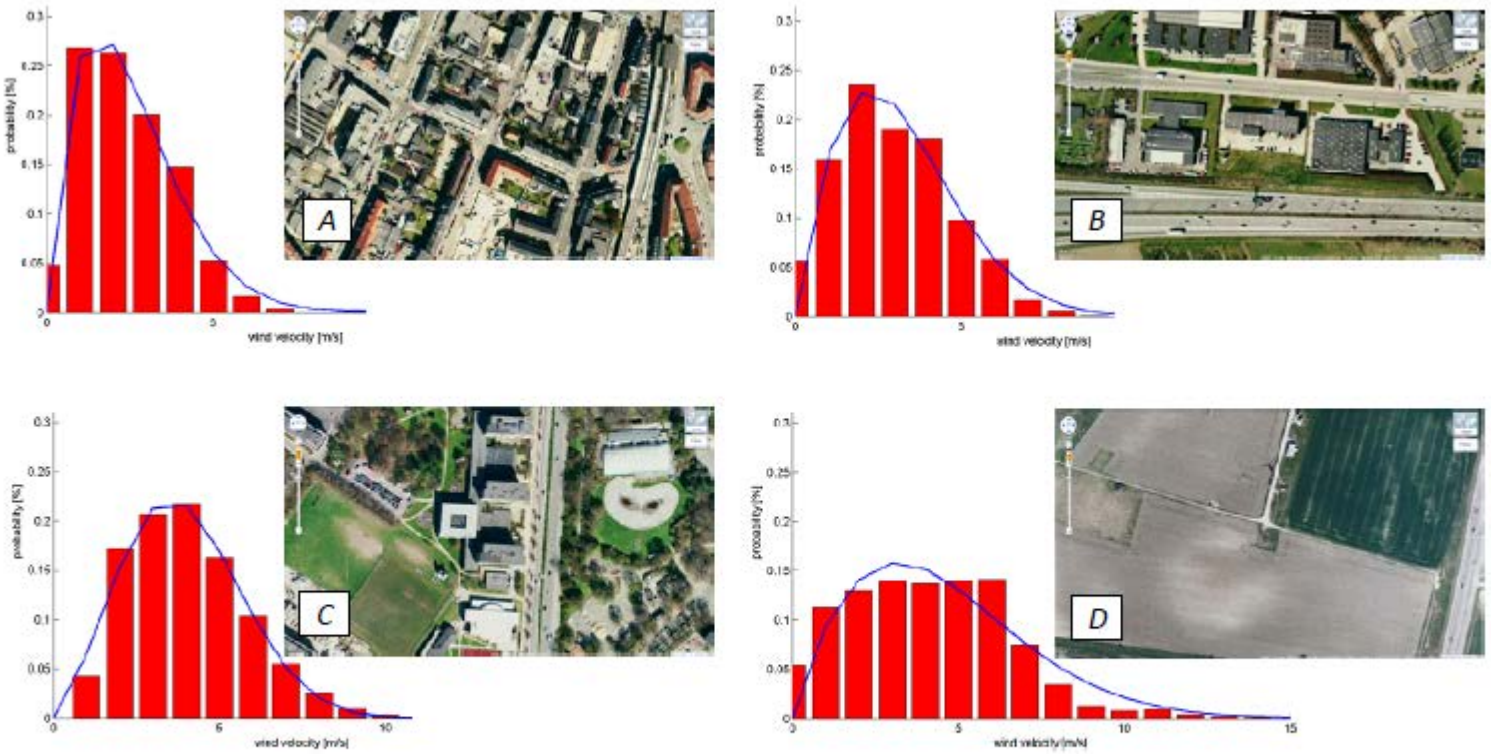
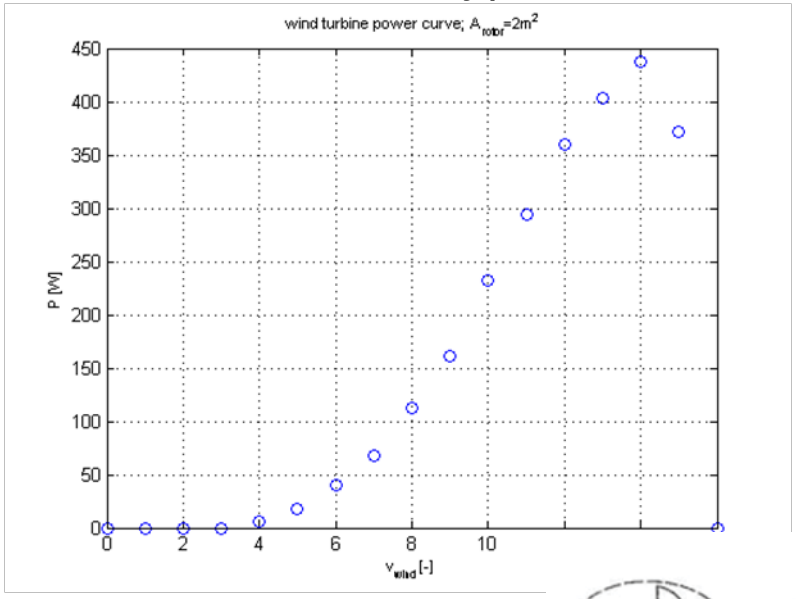


Fig. 106: Weibull distributions for different sites and satellite pictures of the sites

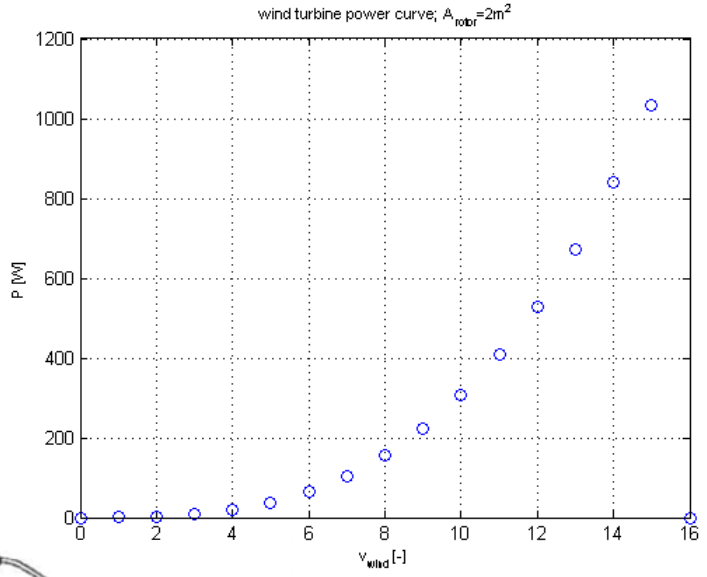
31. oktober 2012

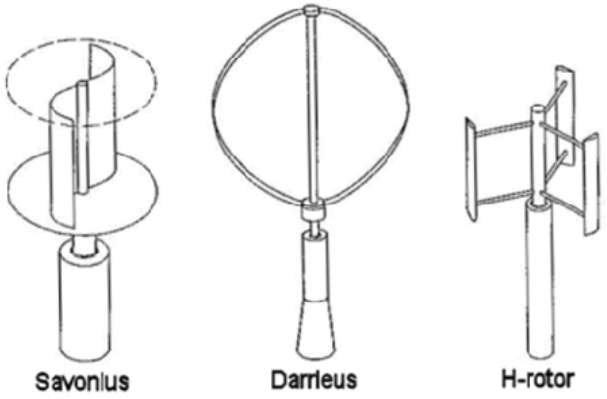
Data for vindturbiner

Darrieus type



Savonius type





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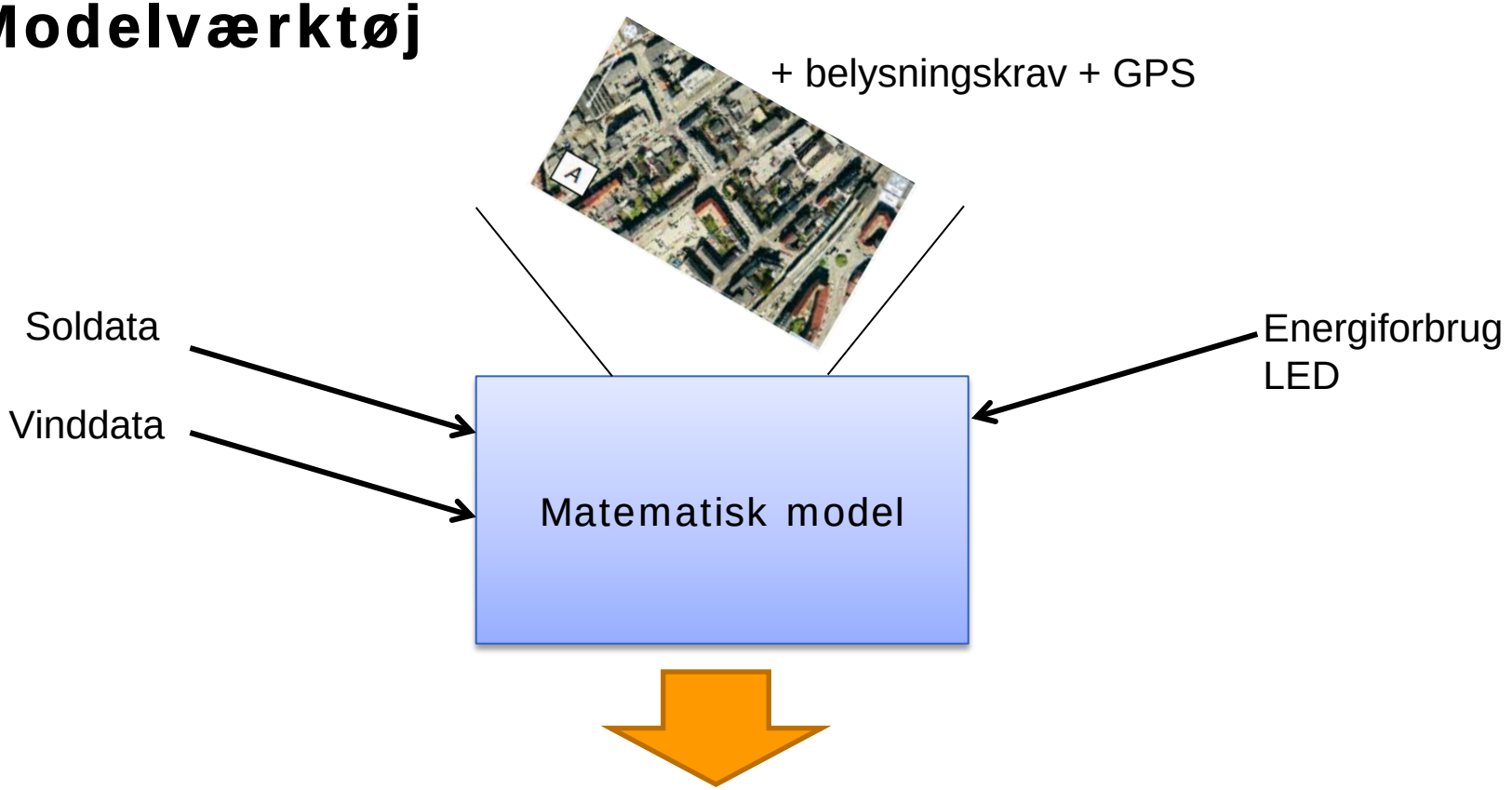
Modelværktøj



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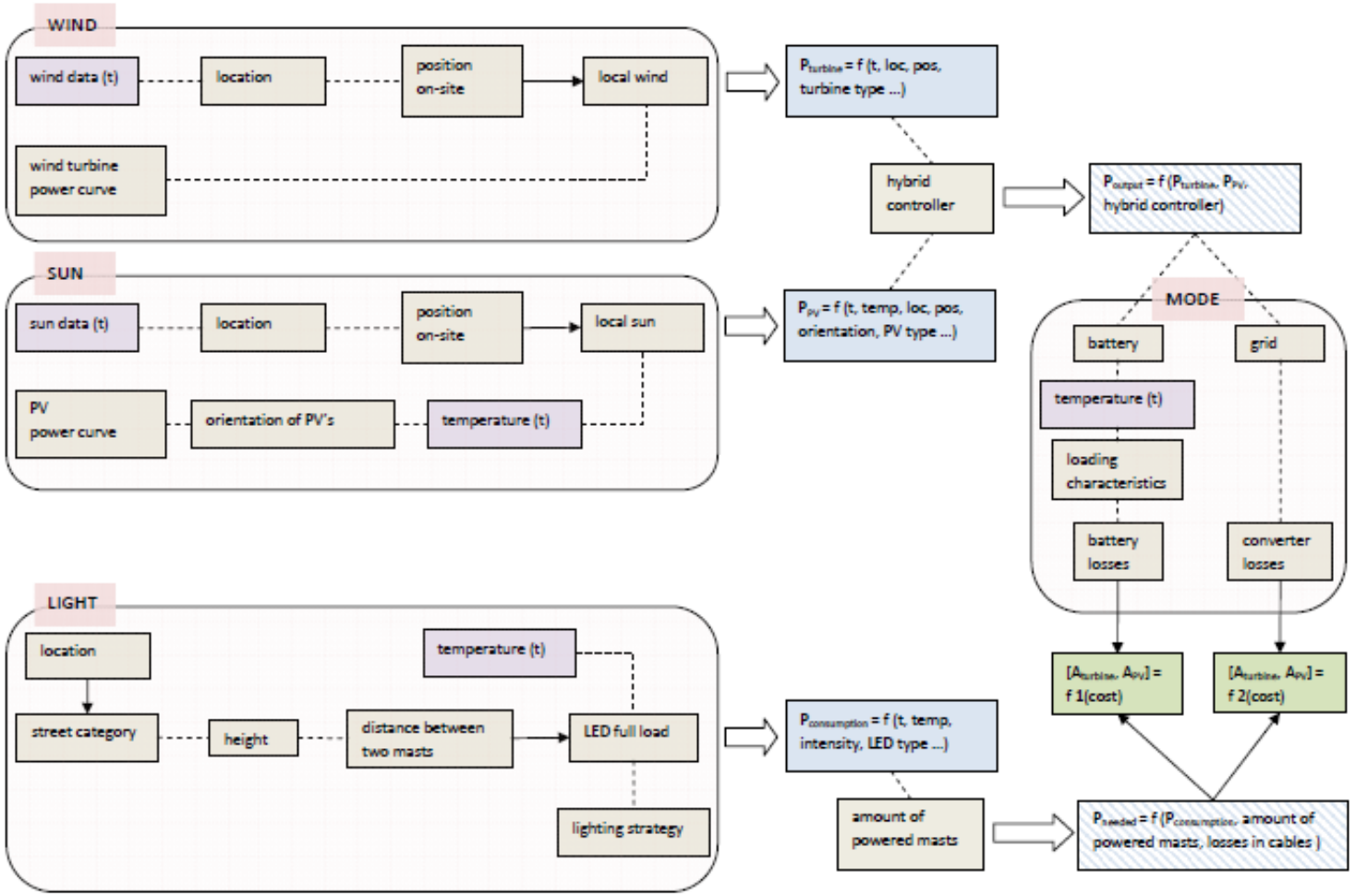
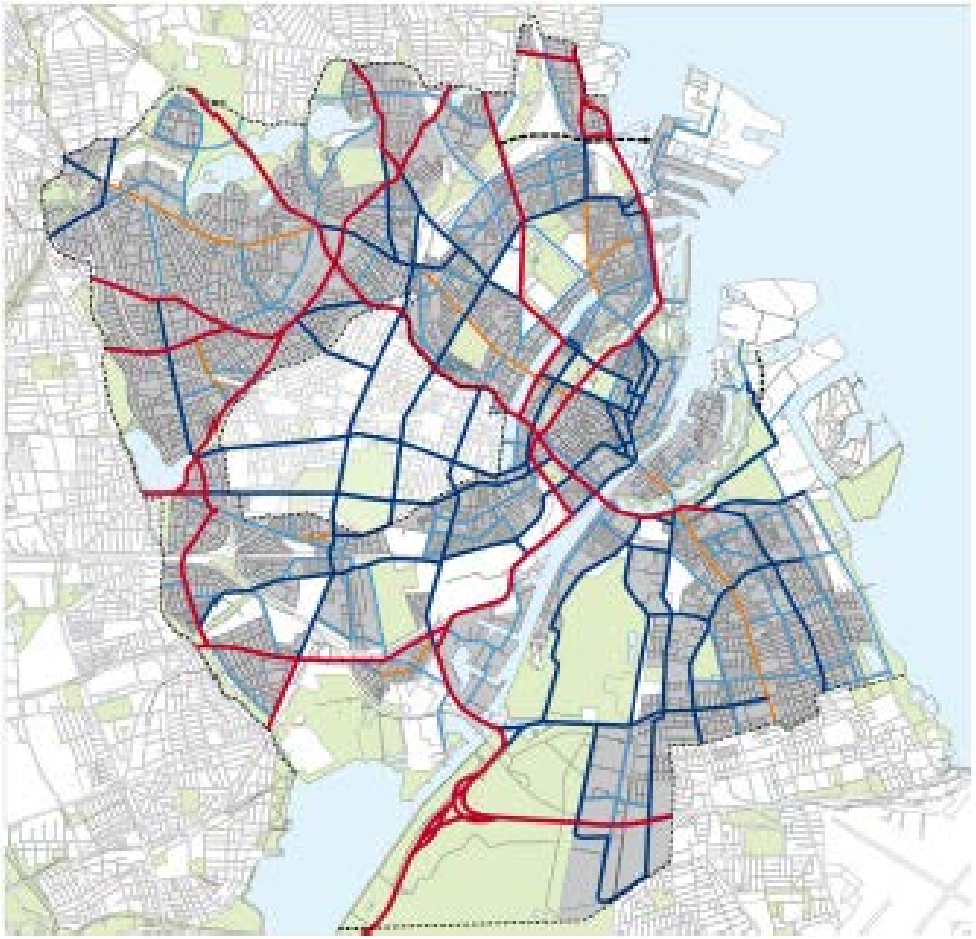
Matematisk modelværktøj



31. oktober 2012

Street classes in Copenhagen



Red: ”Regionale veje”
Dark blue: ”Fordelingsgader”
Light blue: ”Bydelsgader”
Orange: ”Strøggader”
Dark gray: ”Lokalgader”

E2 veje

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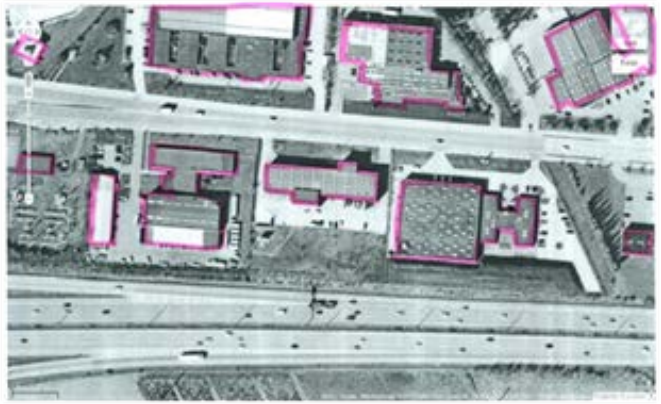
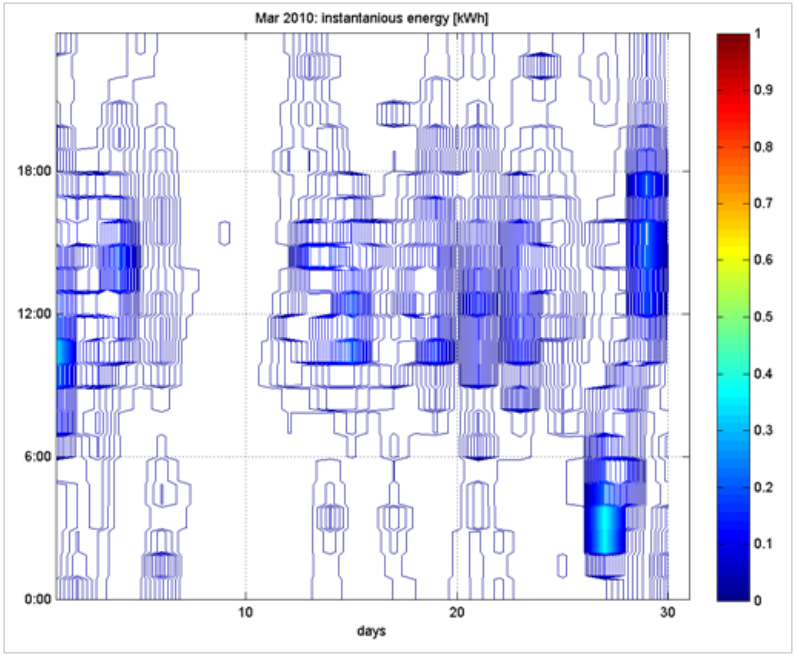
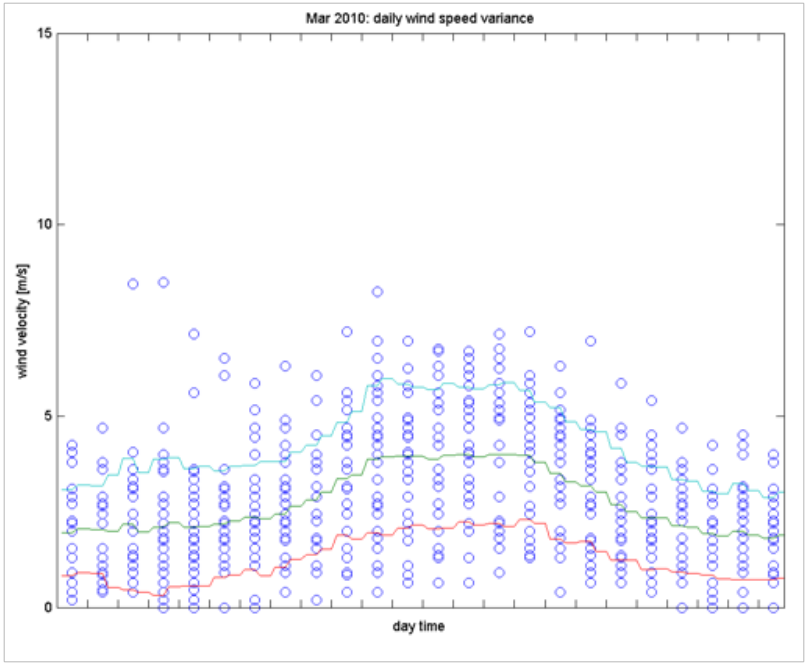
Simuleringer på E2 VEJ!!!







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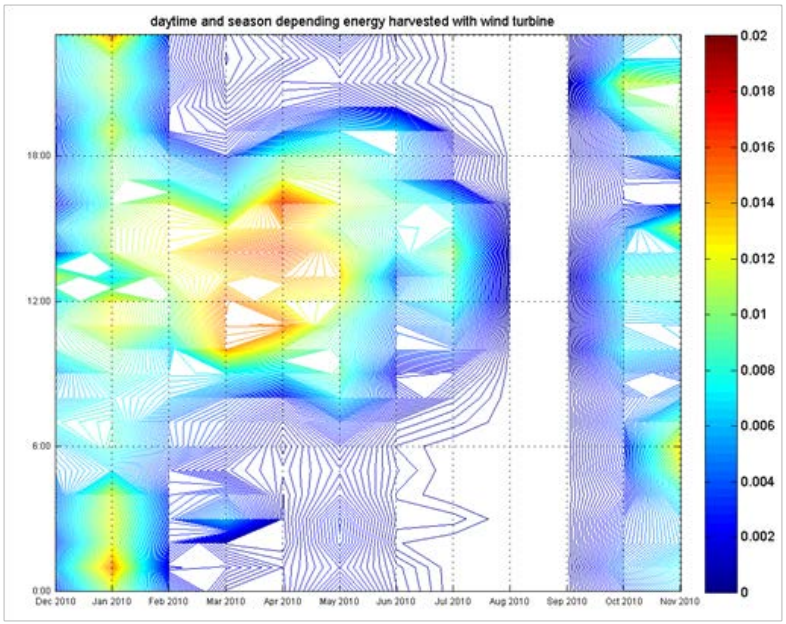
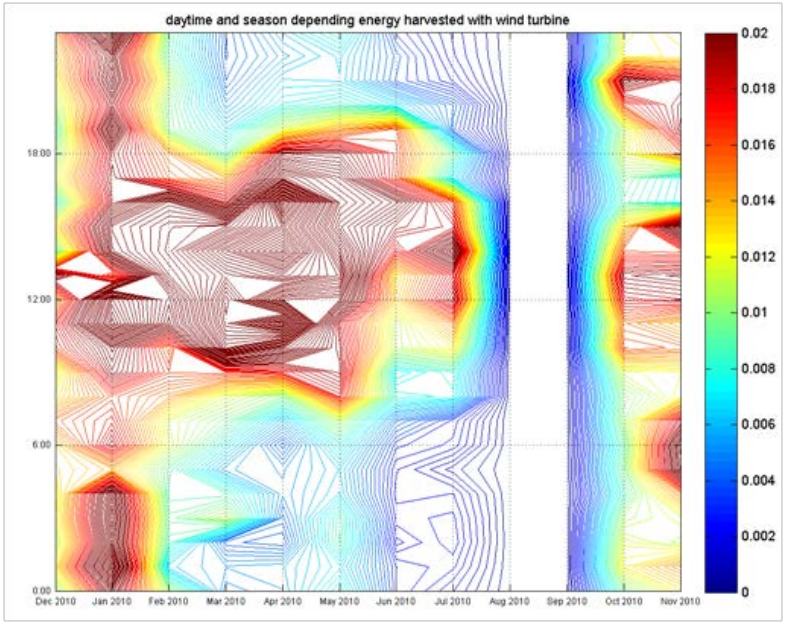
Energihøst som funktion af rotordata

Darrieus type



Savonius type



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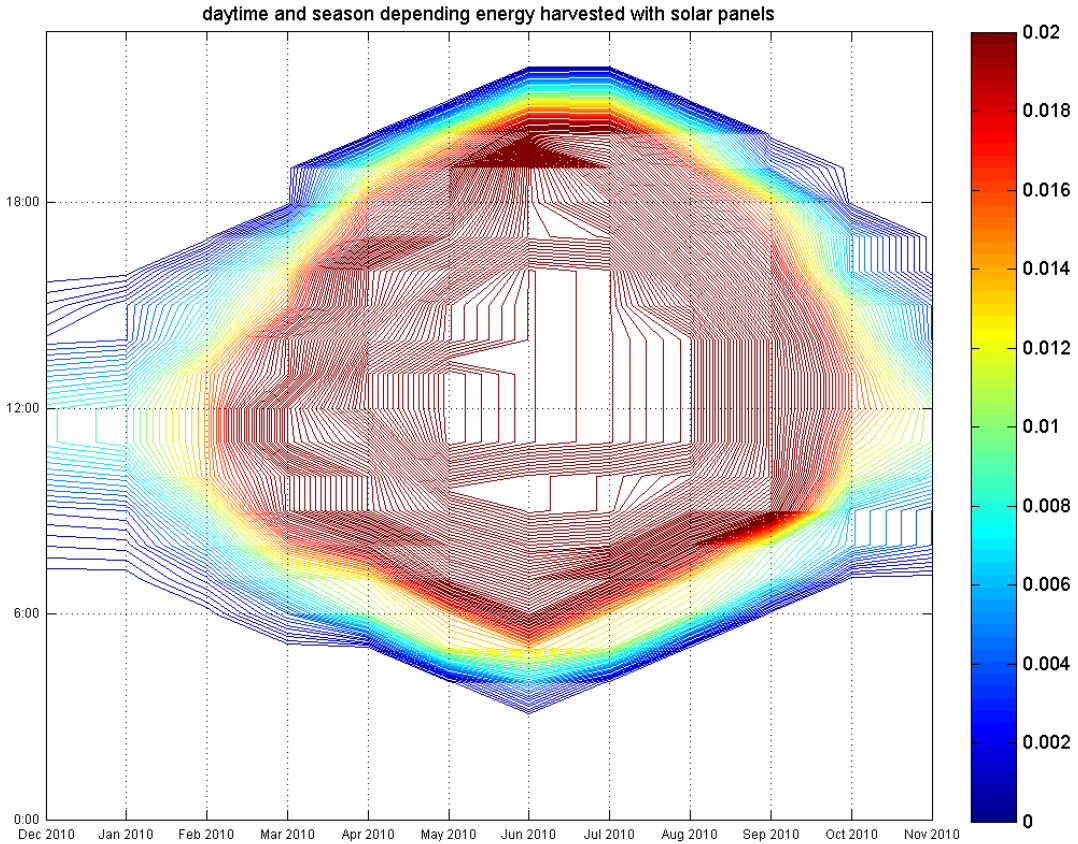
Solenergi



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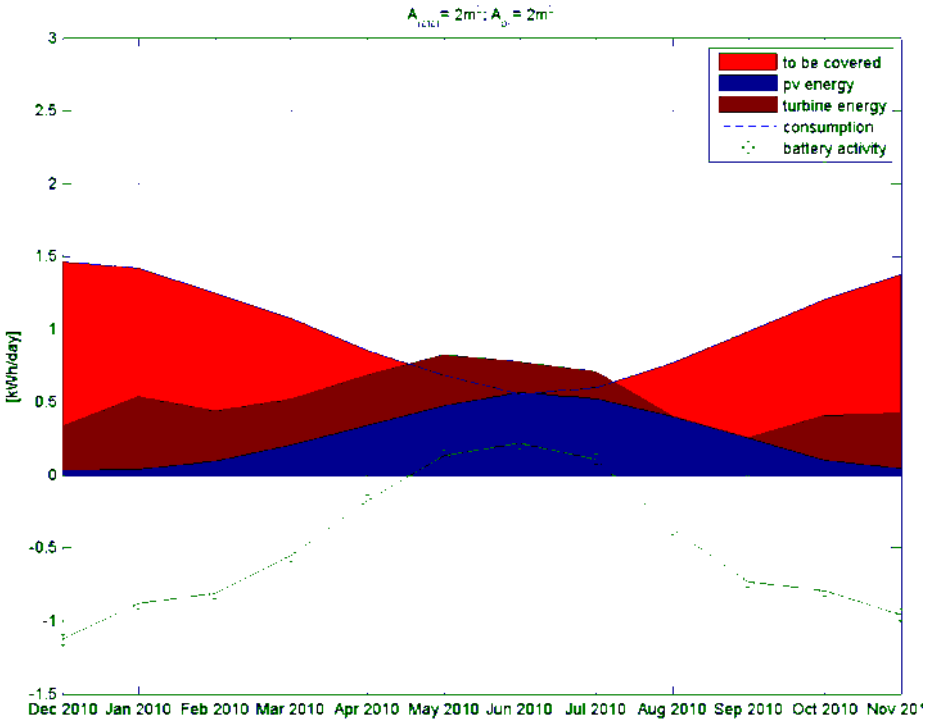
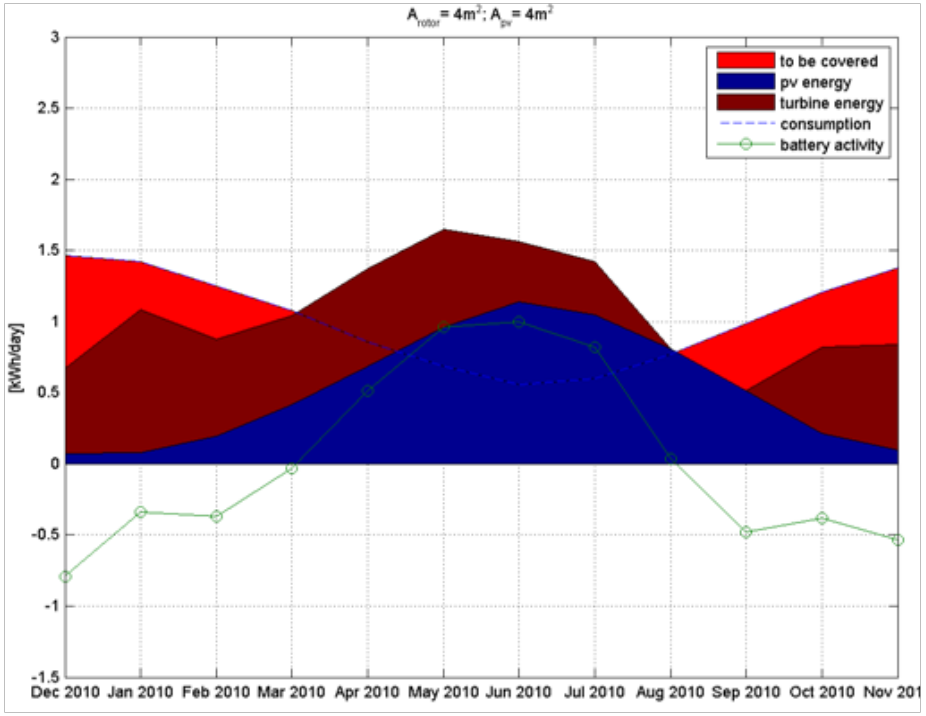
Modellering 2m²/4m² PV/vind

Savonius type





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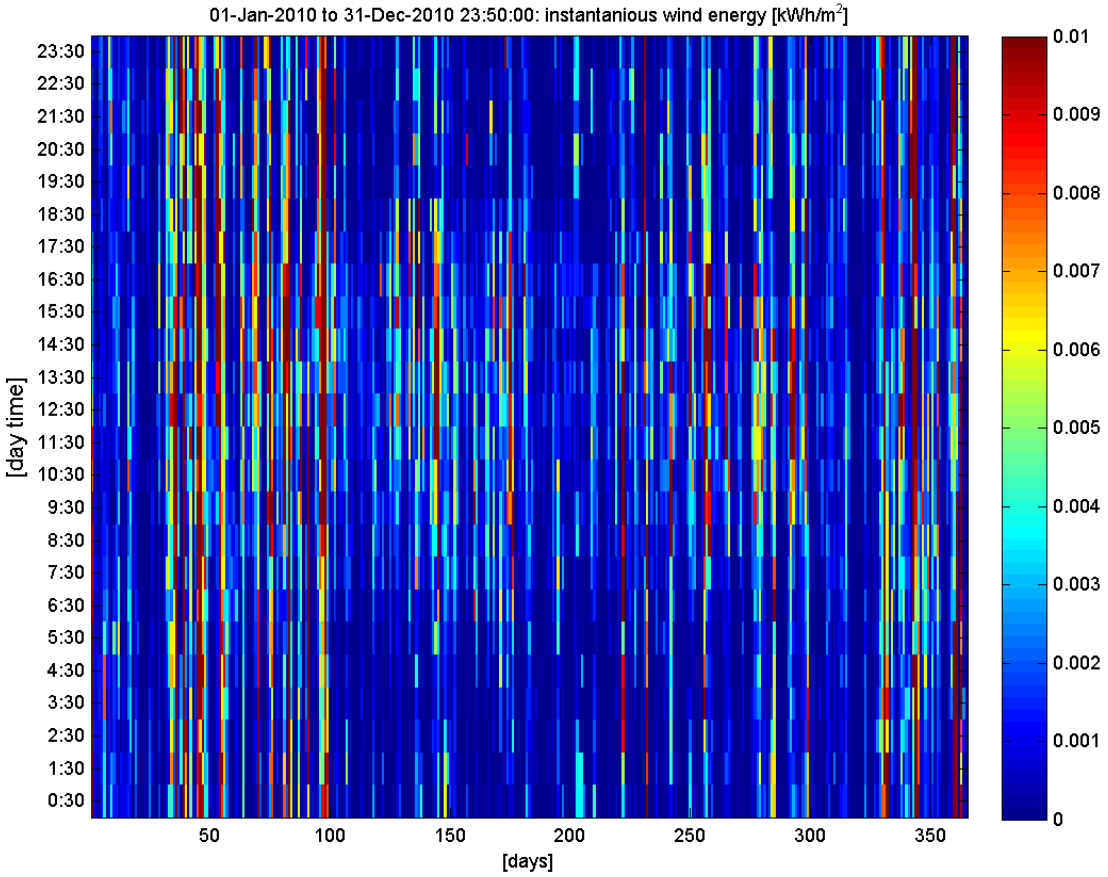
ChinaGreenEnergy - masten



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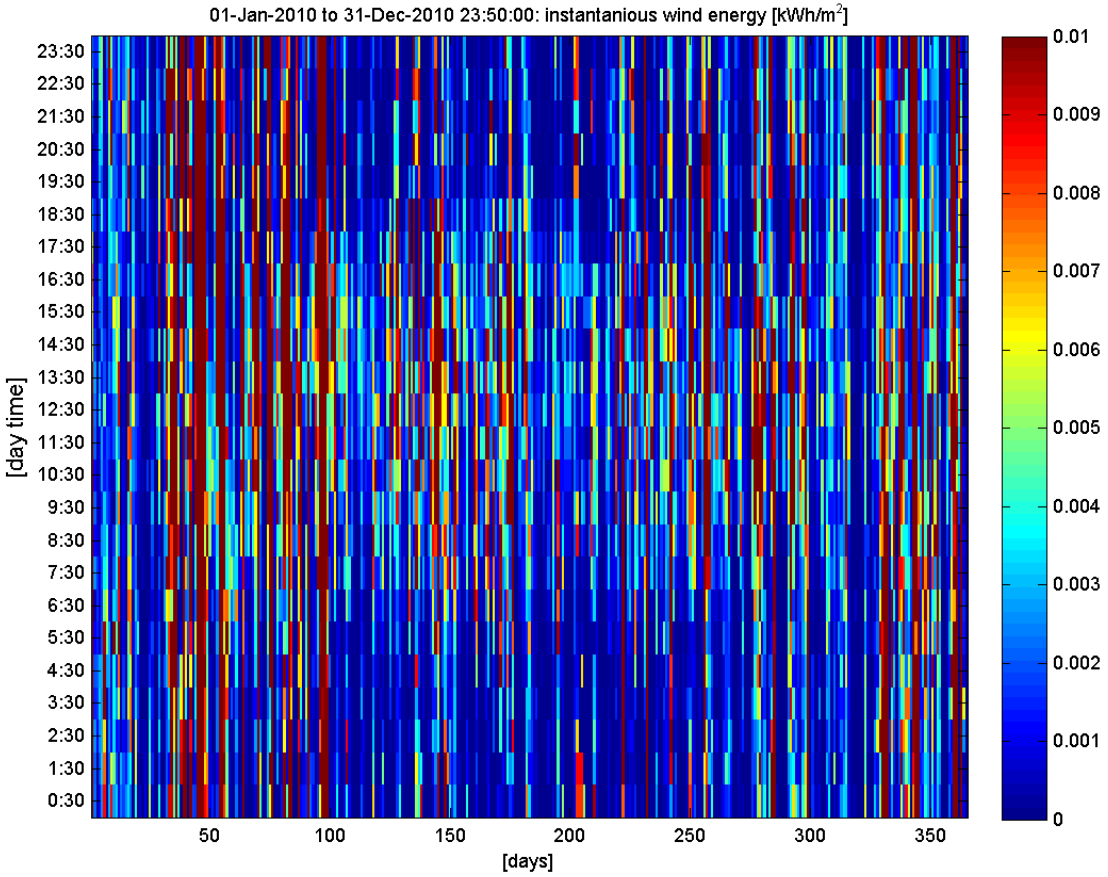
United Electricity



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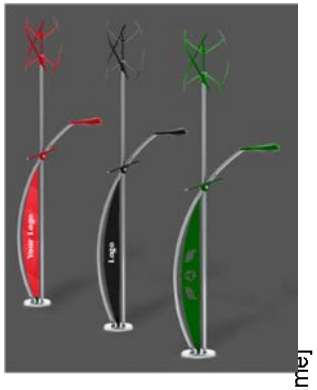
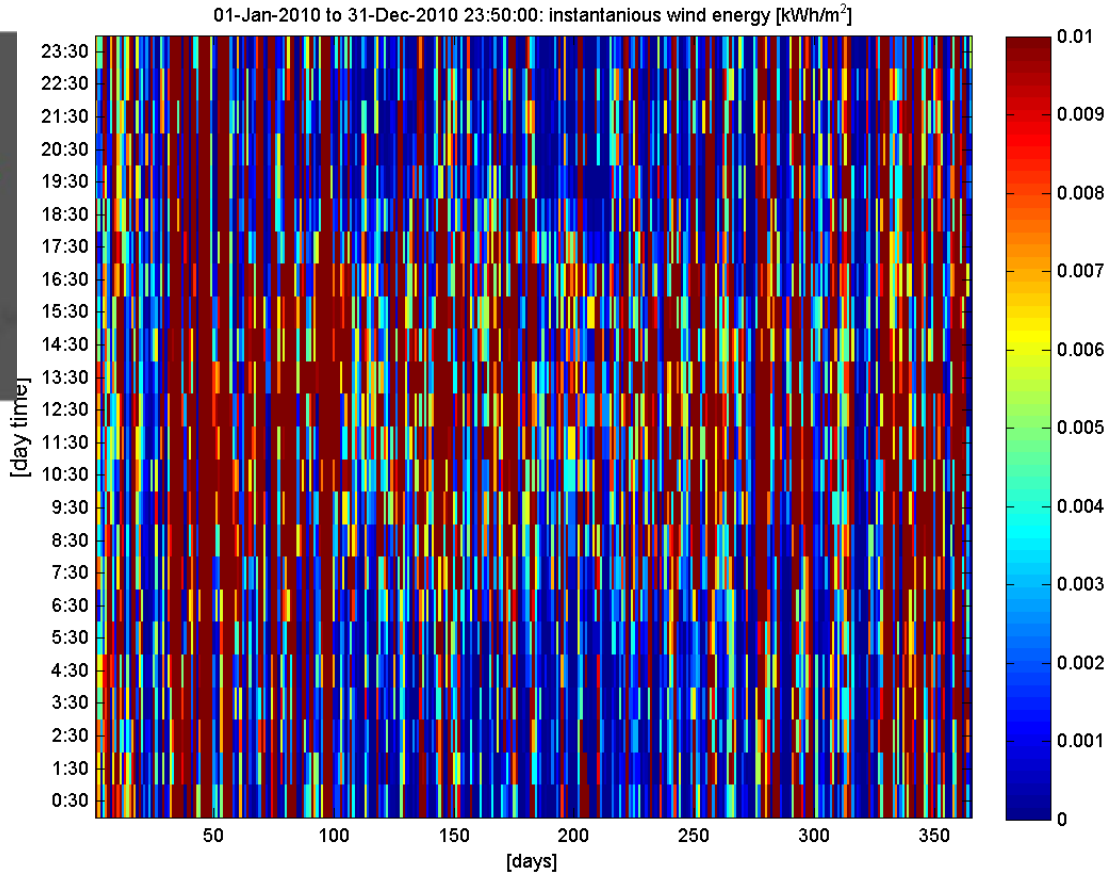
UrbanGreenEnergy





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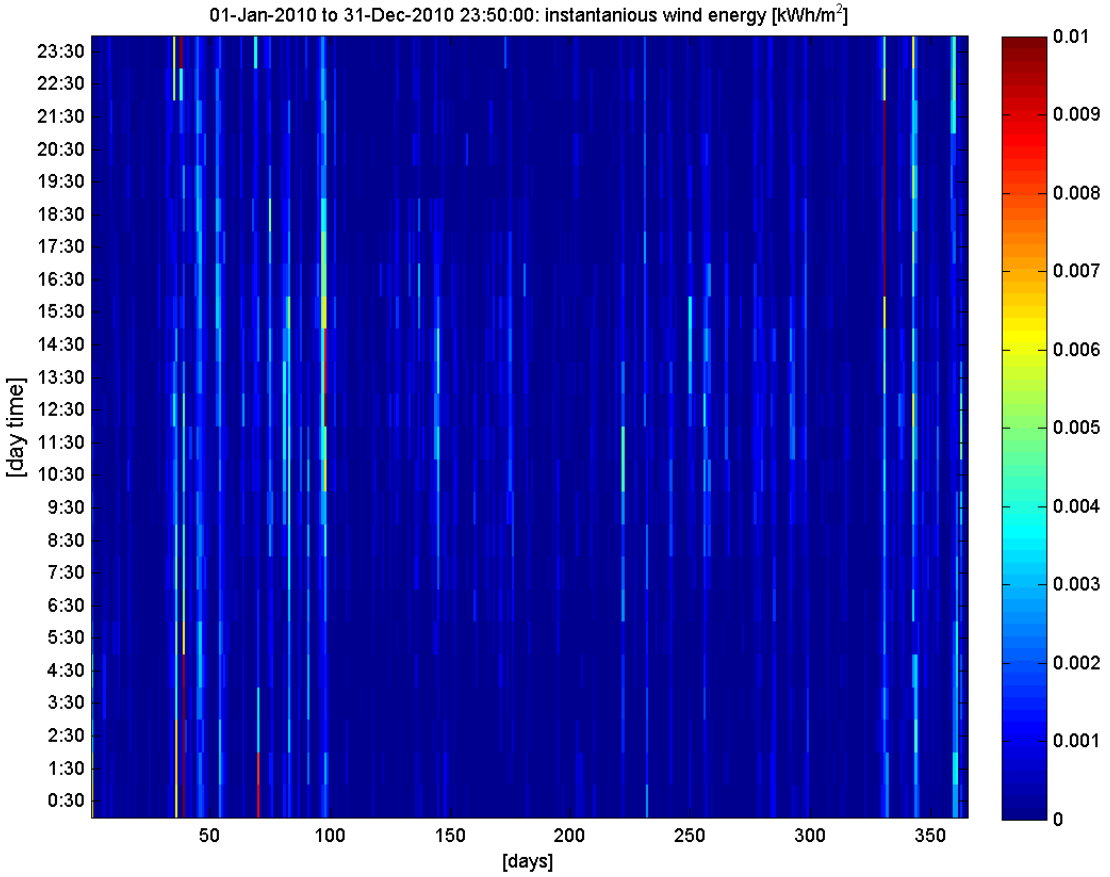
Windelux



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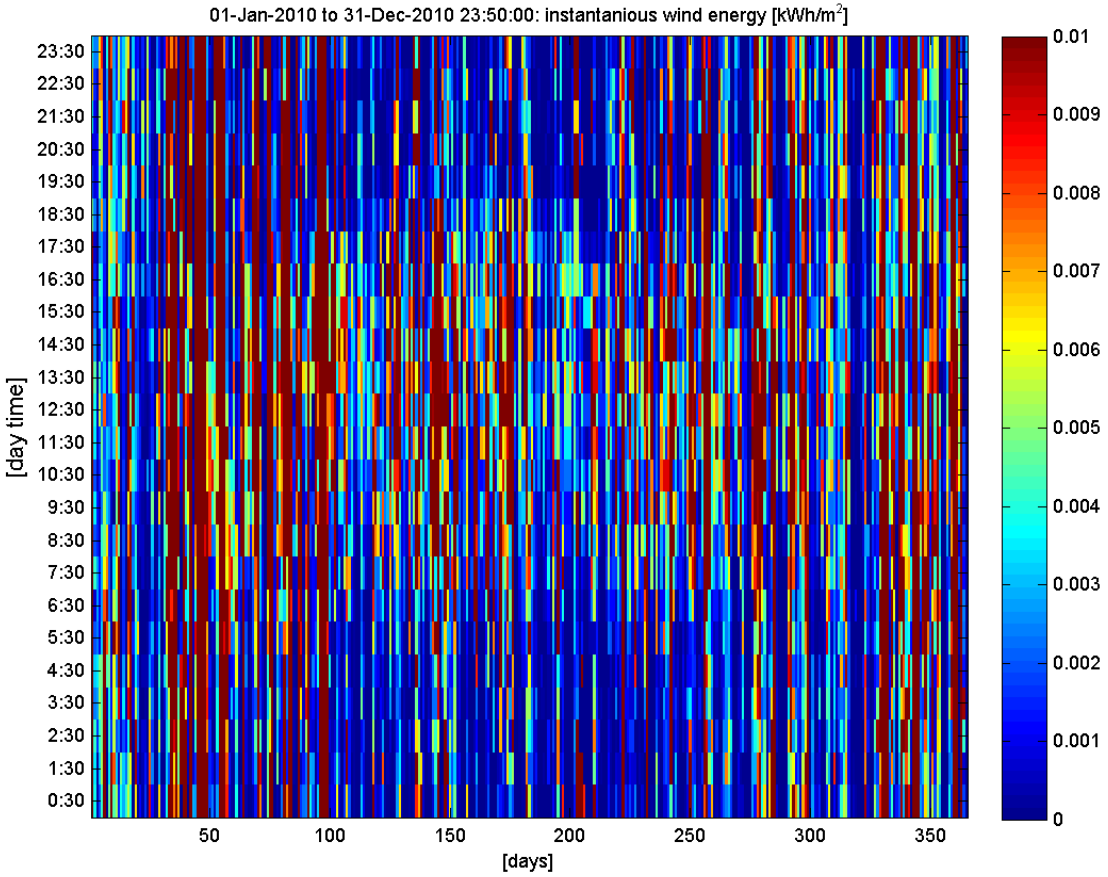
NHEOLIS



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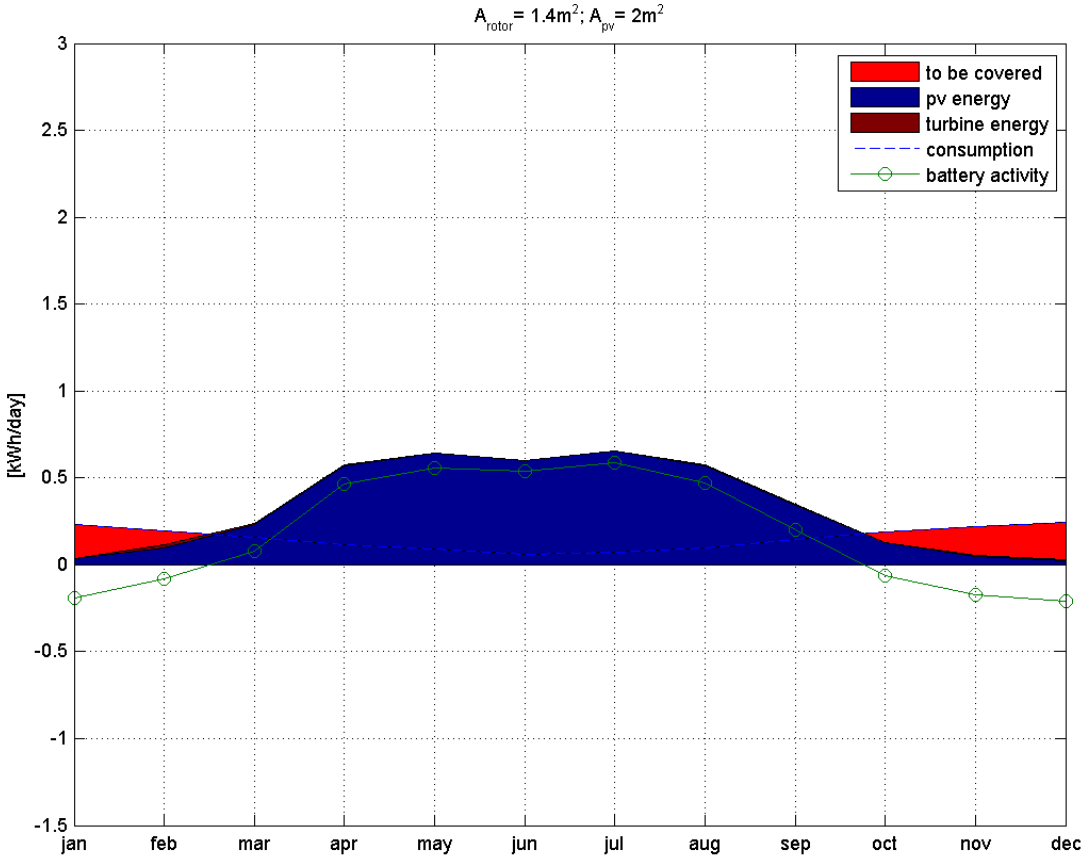
Energibalance - ChinaGreenEnergy



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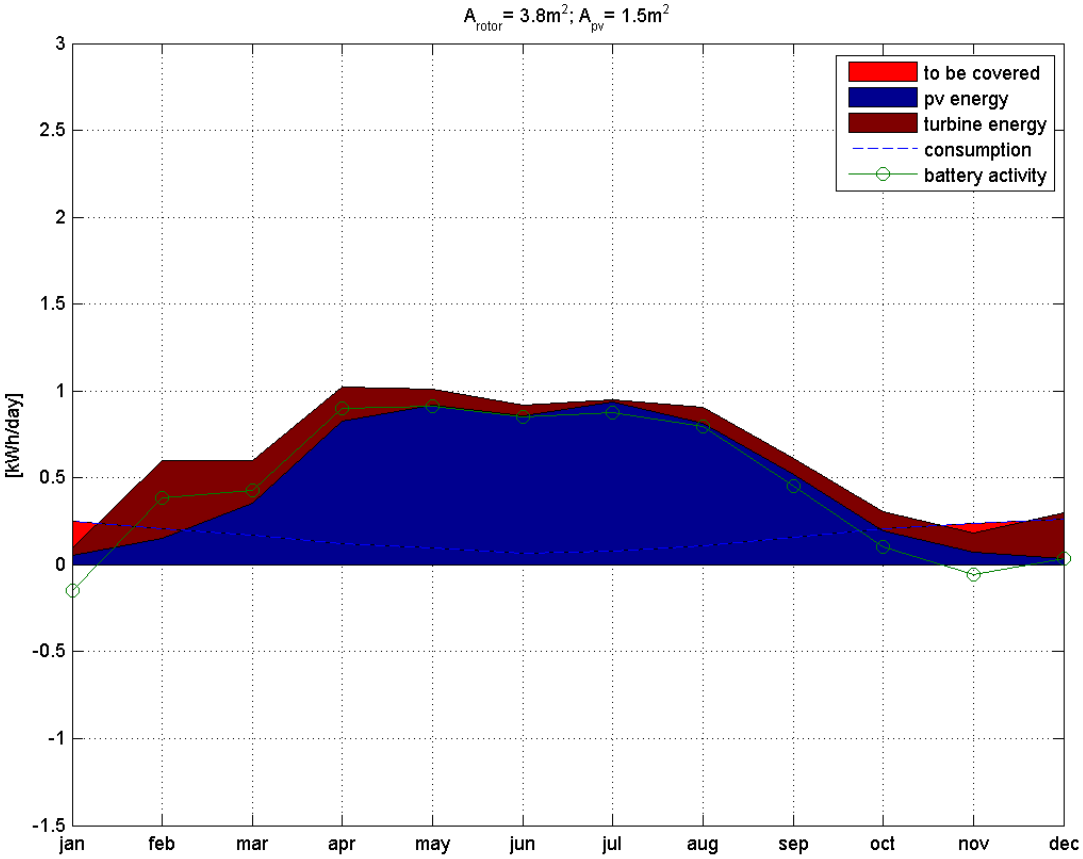
Energibalance – United Electricity



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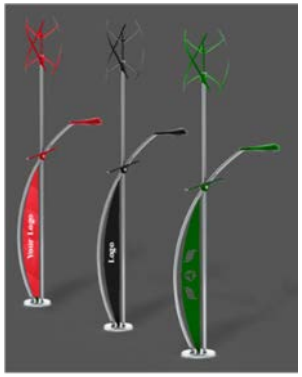
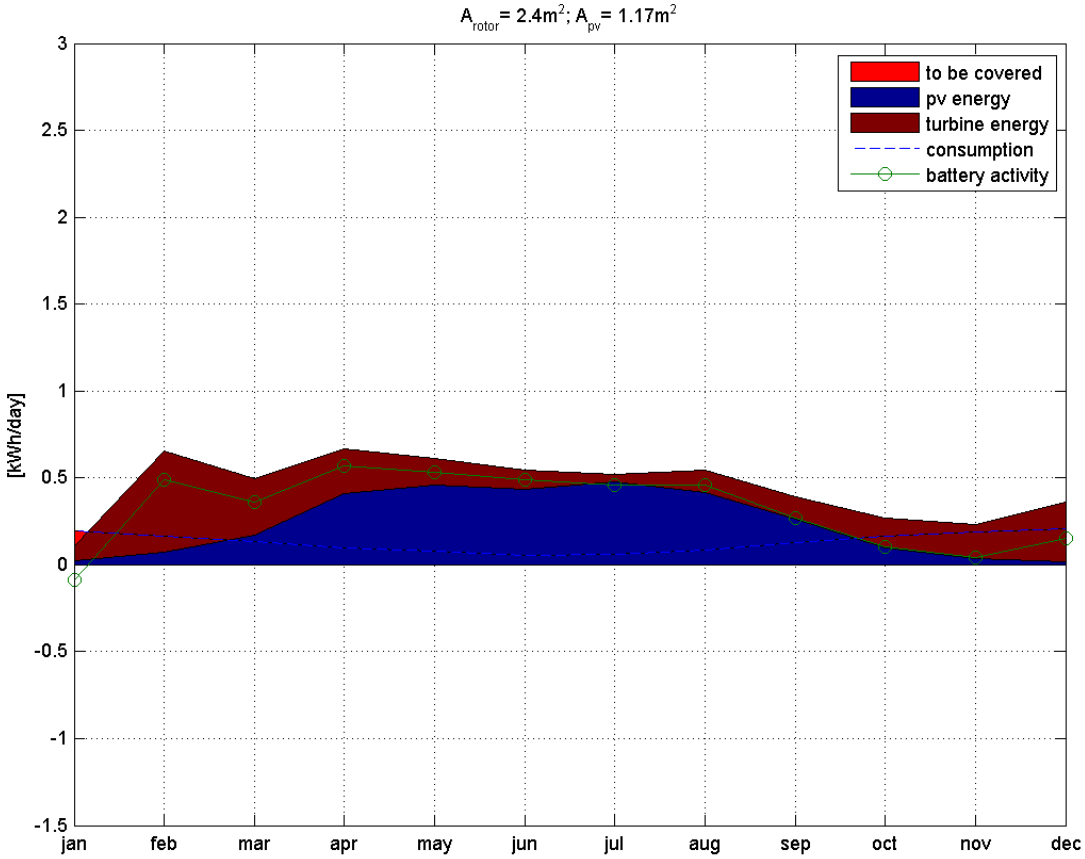
Energibalance - UrbanGreenEnergy





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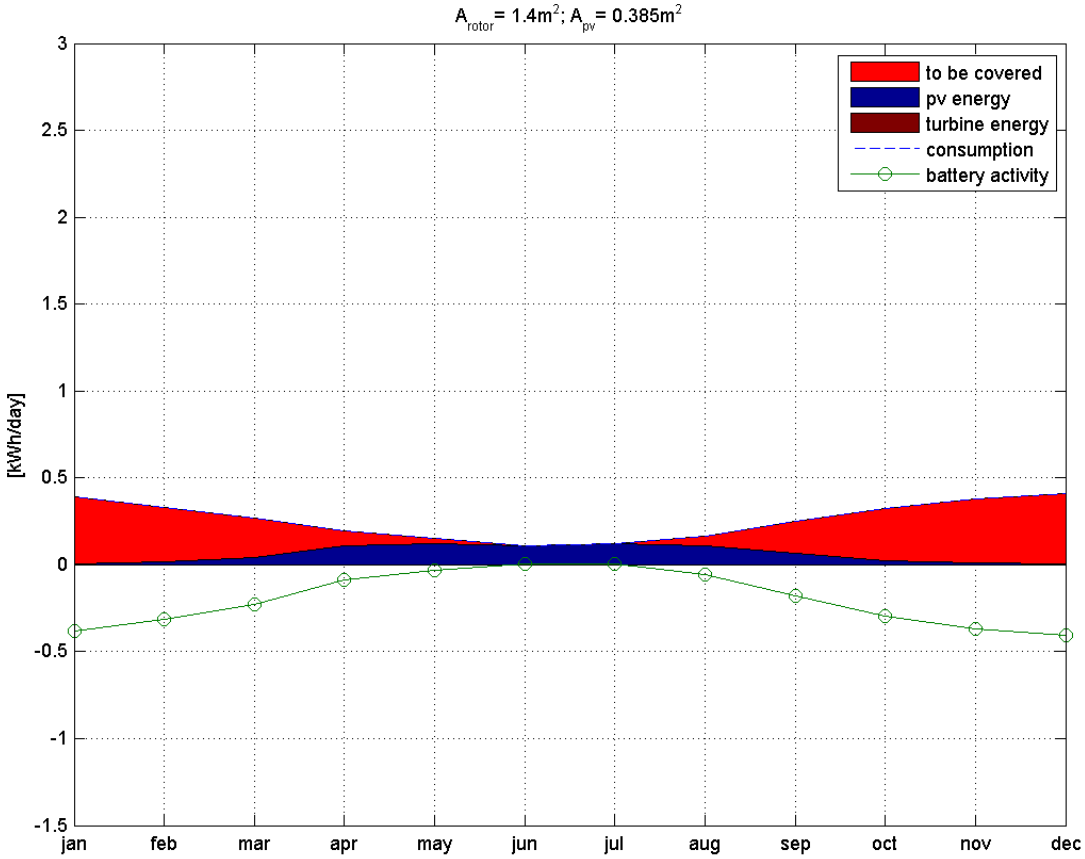
Energibalance Windella



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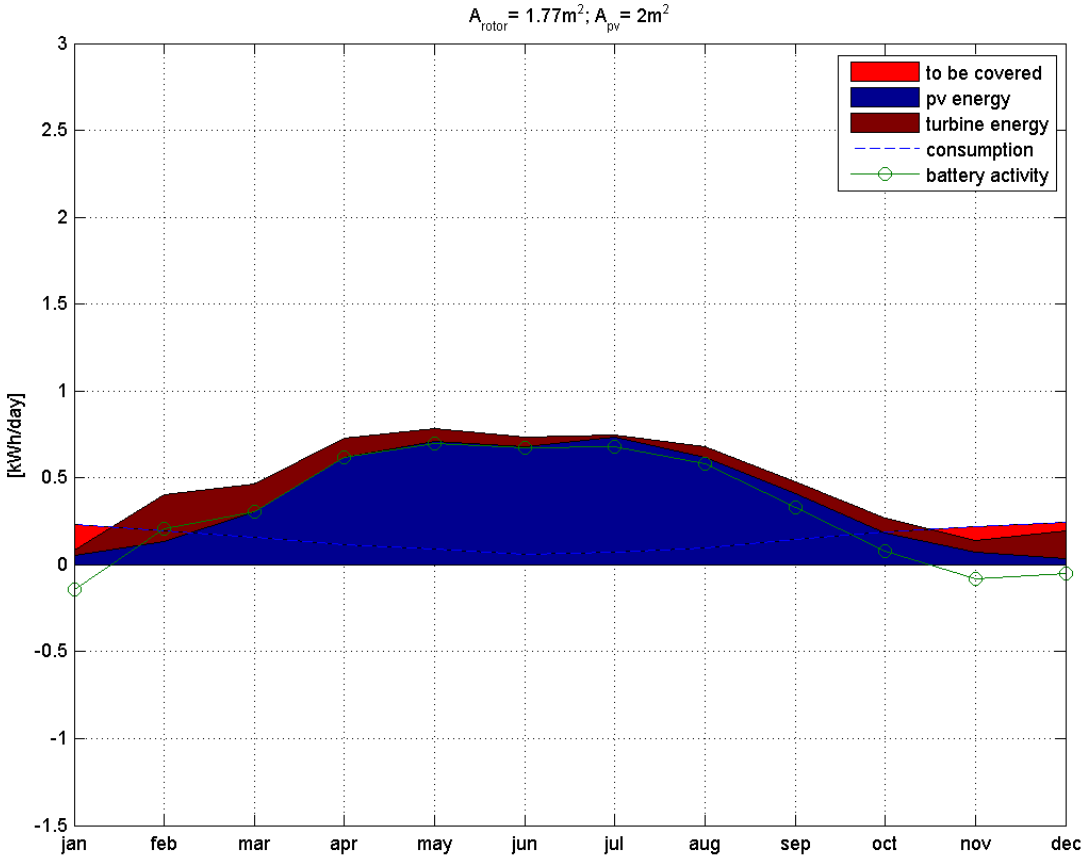
Energibalance - NHEOLIS



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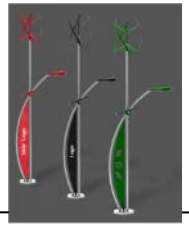
Oversigt master

	MAST I	MAST II	MAST III	MAST IV	MAST V
WIND					
turbine height	7.0m	8.0m	11.0m	6.0m	9.0m
turbine type	Savonius	HAWT	twisted VAWT	Darrieus-Savonius	3D HAWT
turbine area	1.4sqm	3.8sqm	2.4sqm	1.4sqm	1.77sqm
SUN					
PV height	5m	6m	6m	5m	7.5m
PV type	Poly Crystalline	Mono Crystalline	self-defined	self-defined	Poly Crystalline
PV area	2sqm	1.5sqm	1.17sqm	0.385sqm	1.0sqm
PV tilt	45deg	45deg	45deg	60deg	30deg
LED					
LED height	6.0m calc	8.0m calc	?m calc	6.5m calc	6.0m calc
lighting strategy	dimming	dimming	dimming	dimming	dimming
STORAGE					
consumption	55.21kWh	59.60kWh	47.41kWh	93.86kWh	55.21kWh
battery capacity	0.96kWh	2.40kWh	2.10kWh	6.05kWh	1.44kWh
autonomous	no	no	no	no	no
feed-in energy	66.78kWh	168.24kWh	116.30kWh	-70.79kWh	118.60kWh



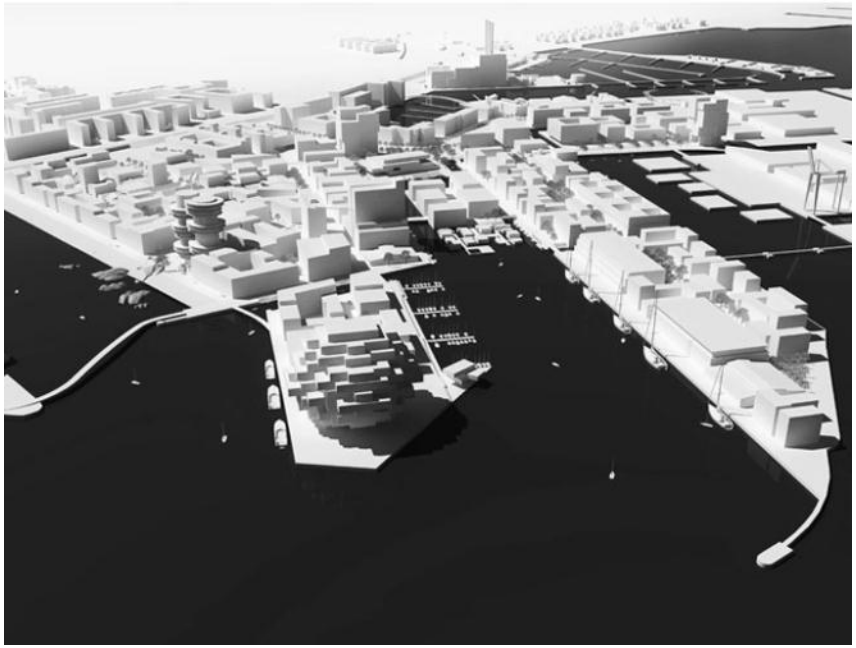


31. oktober 2012

Delkonklusion matematisk modelværktøj

- Stærkt dimensioneringsværktøj/simuleringsværktøj tilvejebragt
- Designprocessen af eget hybridsystem
- Valideres for nuværende med data fra kommercielle systemer
- Gennemsnitsbetragtninger

- Udbygning - punktbetragtninger
  - Google Grabber
  - Interface med arkitektsoftware



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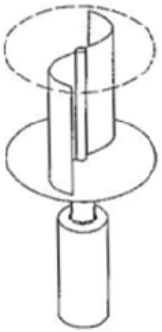
Designrammer

- E2 veje i yderområder
- Lys
  - Max 350 kWh/dag
  - Belyst areal 30x13 m
  - 80% lys falder på vejen
  - 85 lumens/watt (3000 K)
  - 2 x 32 LED enhed Philips
  - Driver Philips
- Vind
  - Savonius
  - 2,3 m^2
- Generator
  - Dia 30 cm, højde 15 cm
- Sol
  - Resten



Savonius

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Designproces

- Henning Larsen Architects
- Faktor 3
- Teknikgruppen


Uranlavej
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Google earth

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Endemål designproces

- Visualisering af
  - Stand alone løsning
  - CO2 neutral løsning

- Gennemregnet økonomibetragtning for de 2 løsninger

Vejklasser	Stand alone	CO2 neutral
E1	God/dårlig	God/dårlig
E2	**God / dårlig**	**God / dårlig**
E3	God/dårlig	God/dårlig
L veje osv	God/dårlig	God/dårlig

- Funktionsmodel af den mest relevante af dem
  - Produktion af vindturbine
  - Speciel generator (udvikles i næste fase)

31. oktober 2012

Konklusion

- Afdækning af kommercielle systemer
  - Design, Energisystem – forbrug - vejr, Rotordesign, Kvalitet
  - Elektriske system (fase 2), Generator (fase 2)
- Matematisk modelsystem
  - Vurdere potentialet for kommercielle systemer
  - Designe nye systemer
  - Feed back fra kommercielle systemer
- Mapping af energipotentiale som funktion af vejklasse/øko.
- Designproces/Funktionsmodel

- Ja, det ser rigtig spændende ud!
  - Stand alone: især eksport ☺
  - CO2 neutral DK fint

- Fase 2 ansøgt ELFORSK – Kæmpe arbejde
  - Generator, energisystem, optimering, produktionsmodning

31. oktober 2012

Tak til ELFORSK

ELFORSK 343-021 - CO_2 neutralt byrumsarmatur

Tak for jeres opmærksomhed!